THE

RUBBER RESEARCH INSTITUTE

OF

MALAYA

REPORT FOR THE PERIOD

JANUARY 1941 TO AUGUST 1945

Published by The Rubber Research Institute of Malaya
and
Printed by Charles Grenier & Son, Ltd., Kuala Lumpur, Malaya.

BOARD

At 31st December, 1941

The Director of the Institute (Mr. H. J. Page, M.B.E.)	Chairman, *ex-officio*
The Hon'ble the Financial Secretary, F.M.S.	Financial Member (appointed by the High Commissioner under section 5 (i) (*b*)) of the Enactment (Cap. 108)
The Hon'ble the Director of Agriculture, S.S., and Adviser on Agriculture, Malay States	*Ex-officio*
The Hon'ble Tuan Sheikh Ahmad bin Sheikh Mustapha, J.P., M.S.C. Che Mahmud bin Mat, M.C.S.	Appointed by the High Commissioner under section 5 (i) (*d*) of the Enactment (Cap. 108)
Mr. Choo Kia Peng, C.B.E., J.P. Mr. D. Farquharson, J.P., M.S.C. Mr. W. A. Wilken, M.C., J.P. (on leave) (Mr. G. S. Reis—acting) Mr. R. Heywood Mr. W. E. Wallis	Appointed by the High Commissioner under section 5 (i) (*e*) of the Enactment (Cap. 108)

Permanent Committee

The Director of the Institute	Chairman, *ex-officio*
The Hon'ble the Financial Secretary, F.M.S.	Financial Member, *ex-officio*.
Mr. Choo Kia Peng, C.B.E., J.P. Mr. W. A. Wilken, M.C., J.P. (on leave) (The Hon'ble the Director of Agriculture acting) Mr. D. Farquharson, J.P., M.S.C.	Appointed by the High Commissioner under section 13 (i) (*c*) of the Enactment (Cap. 108)

REPORTS OF DIVISIONS FOR THE PERIOD JANUARY 1941 TO AUGUST 1945

Owing to shortage of staff and other dislocations of the work of the Institute caused by the war, it has been found impossible to complete the Annual Reports since 1940. The reports of the several Divisions of the Institute have, however, been compiled, and the reports for the period 1st January 1941 to 31st August 1945 are here produced in a single volume. The reports of the Board, the Director, the London Advisory Committee for Rubber Research (Ceylon and Malaya) and the statements of accounts will be published later.

It is hoped that a second volume of Divisional reports covering the years of reconstruction, September 1945 to December 1948, will be ready for printing shortly after this report is distributed.

C. C. T. SHARP,
Acting Director.

KUALA LUMPUR,
August 1950.

CONTENTS

	Page
Report on the work of the Soils Division ..	1
„ „ „ „ Botanical Division ..	8
„ „ „ „ Pathological Division ..	41
„ „ „ „ Chemical Division ..	69
„ „ „ „ Experiment Station ..	82
„ „ „ „ Smallholders' Advisory Service ..	95
Indexes	100

REPORT FOR THE PERIOD
JANUARY 1941—AUGUST 1945

SOILS DIVISION

Part I—January-December 1941

This section has been compiled from the reports made in 1941 on the work done for the first three quarters of the year.

STAFF

There were no changes in the Senior Staff of the Division in 1941. The Assistant Soils Chemist, Mr. K. S. Pillay, was on long leave in India until April 1941.

Continuous military training caused the absence of all the Senior Staff for two months during the period February to April, and in May temporary mobilisation caused Mr. Owen's absence for two weeks. Both the Head of the Division and Mr. Davidson were mobilised for military duties from 1st December 1941, and later in the month Mr. Owen was engaged on Passive Defence duties.

Four new field assistants were appointed, and two resigned during the year.

I. Soil Survey Work

Laboratory work on existing profile samples was maintained, but the identification and classification of new soil types was considerably retarded.

Following a conference in May on peat soils, with officers of the Agricultural and Forest Departments, at which the points discussed included classification of peat soil types, laboratory methods to be used for the examination of peat soils and the mapping of peat soil areas in Malaya, data regarding peat profile samples and peat areas on rubber estates were assembled by the Soils Division, and plans for future co-operative work between the three departments were arranged.

II. Manuring Hevea

A. Mature rubber

Previously established manuring experiments on estates and at the Experiment Station were continued; measurements of growth and yield were maintained and fertiliser applications were given. Girth improvement in some experiments were detected after three years of fertiliser treatment, but yield responses were small and not significant.

A new series of experiments, in conjunction with the Chilean Nitrate Corporation, was planned for comparing nitrate of soda with sulphate of ammonia as fertilisers for mature rubber trees aged about fifteen years. Four areas on estates were selected from over twenty which had been inspected, and the plots were marked out in the field for preliminary yield recording prior to the application of fertilisers.

In conjunction with the Drainage and Irrigation Department the possibilities of irrigation of rubber on flat land on an estate in a district which regularly experiences very dry conditions were examined. Considerable difficulties were anticipated in carrying out any experimental work on irrigation, and land surface levels which had recently been taken were being closely examined preparatory to commencing an experiment.

Proposals were made for improving yield recording in experimental areas, particularly in drying the rubber samples.

The difficulties in obtaining fertiliser supplies caused enquiries to be made for substitute fertilisers, and modifications were made in many estate manuring programmes. Wood ash, obtained from smoke-houses on rubber estates, was a satisfactory source of potash, and ground-nut cake imports from India and nearby countries were increased to supply nitrogen. The use of these substitutes created a number of minor problems and produced many enquiries from estates regarding methods and rates of application.

B. Young rubber in new clearings

All previous experimental areas were maintained, with growth measurements continuing to demonstrate the benefits from phosphate manuring. Differences in clonal development were noticeable, but no clone with fertiliser interactions appeared.

In co-operation with soils officers of two rubber estates, a detailed experiment was devised to study the effects of "burning" versus "no burning" on the soil and on rubber plants in a large new clearing of 400 acres. Soil profiles were sampled, and a series of monthly soil samplings and analyses was initiated.

Damage in experimental areas was caused from time to time by small but severe wind storms, and the degree of damage appeared to be related to the clone affected; thus, the stiffer clones, such as P.B. 86, resisted the wind and broke, but Pil. B.84 bent readily and later recovered.

Bending caused by strong winds was in almost all cases remedied by using rotan guys or wooden props, although with the latter chafing of the main stem at the point of attachment was liable to occur.

Damage in other experimental areas was caused by elephants, and paint used for marking trees produced serious dieback in young buddings twelve months of age, owing to a toxic constituent in the paint.

C. Young replanted rubber

The older experiments continued showing growth benefits from phosphate and nitrogen manuring, but not from potash fertilisers.

Comparisons between nitrate of soda and sulphate of ammonia were commenced in four new experiments, in two of which the initial applications of fertilisers were made. Other replanting experiments were commenced on coastal clay soil and on quartzite sand.

Bending of the trees in young replantings was investigated, but could not be linked with excessively heavy doses of fertilisers. It occurred where unusually large crowns were subject to strong winds, and no damage resulted if temporary support was given to the stems. In a few cases, some light pruning of side branches was required.

D. Time of Application of Fertilisers

Experiments were commenced to compare different nitrogenous fertilisers applied at two different times of the year.

No positive results were obtained from the older experiments which were continued.

III. Cover Crops

The taking of growth records in experimental areas was continued. General indications were obtained, both in experiments and from observations on estates, of the indirect benefits to young rubber trees where phosphatic manures had been applied to the covers, and although used to help establish legume covers, the manures had improved rubber tree growth.

Beneficial effects from mulching young plants appeared to be small after the first year of growth, according to figures obtained from one experiment (S.G. estate).

Age of trees	Average girths		
	Mulched	Not mulched	Difference
Nov. 1938—12 months ..	3.51 ins.	3.20 ins.	.31 ins.
Nov. 1939— 2 years ..	6.95 „	6.60 „	.35 „
Aug. 1949— 2¾ years ..	10.22 „	9.79 „	.43 „
Nov. 1941— 4 years ..	17.16 „	16.72 „	.44 „

From experimental areas growing three types of covers—legume creepers, legume bushes, and mixed indigenous covers—the growth measurements listed below showed small but consistent effects of the covers on the development of young buddings and a tendency for growth to be slightly less retarded in the natural cover treatments.

Average girth in cms.

Estate	Age in Years	Creeping Legumes	Bush Legumes	Natural Covers	Normal Burn	Light Burn	No Burn
SB ..	2	17.7	17.5	17.6	17.5	17.1	18.2
SX ..	3.2	26.6	26.8	27.0	28.1	26.2	26.2
SV ..	2.5	25.5	25.8	26.2	25.5	25.9	26.1
SE ..	1.5	11.1	11.3	11.6	11.6	11.5	11.0
SK ..	1.1	9.4	9.9	10.2	10.5	10.0	9.2

The five experiments listed above also compared the effects of different methods of preparing the land for planting, and in two cases growth in the area of " normal burn " was best (SX and SK), but no definite conclusions can be drawn from these figures.

Measurements from three experimental areas, (SL, SCH, SP) where the various types of covers were dug-in revealed no benefits from this operation.

Average girth in cms.

Estate	Age in Years	Indigenous Covers		Bush legumes		Creeping legumes			
		Not dug	Dug in	Not dug	Dug in	Circle weeded	Strip weeded	Dug in every 3 months	Dug in every 6 months
SP	2.7	23.1	23.7	23.0	22.5	19.8	23.3	21.7	21.3
SCH	1.5	13.3	14.0	13.5	13.3	13.6	14.1	13.9	13.6
SL	3.0	28.3	27.8	26.6	25.4	28.0	27.9	27.5	28.3

IV. Laboratory and Pot Culture Work

Considerable difficulties were experienced in renewing supplies of chemicals from Great Britain, and alternative sources of supply for certain chemicals had to be sought in America. These delays in obtaining fresh chemicals greatly restricted some of the laboratory work.

Shortage of fertilisers stimulated interest in locally obtained bat guanos and, as the chemical composition of these guanos is liable to vary considerably, numerous samples were received for analysis.

Investigations on the phosphate status of Malayan soils were continued by Mr. Owen, and certain sections of the work were prepared for publication. The lines of work followed included (a) comparisons of the degree of fixation in the soil of various inorganic and organic forms of phosphate; (b) the effect of pH on phosphate fixation in the soil; (c) the change of phosphate availability with time after application in the soil; (d) the effect of concentration of the added phosphate on the degree of retention of phosphate by different soils; (e) the response of tomato plants in pots to phosphates added to different soils; (f) the examination of methods of estimating organic and total phosphorus in soils.

The poor growth of young rubber plants in certain peaty and peaty clay soils was closely investigated to ascertain the nature of any toxic conditions present. The main conclusions were that reducing conditions, occurring as a result of water-logging close to the surface, produced harmful effects, and that accumulations of hydrogen sulphide and ferrous compounds in the water-logged horizon caused toxic conditions. Most of this work was prepared for publication.

Work continued on rubber tree analysis.

In connection with the Entomologist's investigations on cockchafer grubs a series of mechanical analyses was carried out of soils taken from areas in which grubs had been found.

A comparison of methods of analysis of available potash in soils was made between those used by the Department of Agriculture and those used in the Institute. Apparent discrepancies had previously been detected when comparing results from the two laboratories, but these were found to be due to great differences between the soil types undergoing examination and close agreement between the results from the two sets of laboratory workers was finally obtained.

Advisory Work 1941

Statistics for correspondence, visits to estates and experiments, and interviews are incomplete, but those available indicate that in the nine working months of the year, the numbers for a full twelve months would have been the same order as attained in previous years. No lectures to planting associations and societies were delivered in 1941.

Part II—January 1942-August 1945

No member of the Senior Staff was on duty in the Division during this period. The Head of the Division (C. G. Akhurst) and the Advisory Officer (L. R. Davidson) were on military service until 15th February 1942, when they became prisoners-of-war in Changi, Singapore and Siam until September 1945. The Soils Chemist (G. Owen) was engaged in Passive Defence duties and was interned in Sumatra until September 1945.

In mid-January the Institute was closed and the Staff was dispersed. Much looting took place and there was a considerable loss of chemicals and apparatus. Work was resumed

in June 1942, by which time almost all the Junior Staff had been re-engaged and the Assistant Soils Chemist, Mr. Pillay, remained in charge of the Division until September 1945. During 1943 and 1944 many changes in personnel occurred, through transfers to other divisions, voluntary resignations, and dismissals, and nearly thirty new appointments were made between 1943 and 1945.

Growth measurements were recorded on a number of experimental areas on estates, but this work ceased in June 1943 when considerable restrictions on travelling were imposed. Recording work continued at the Experiment Station until the end of 1943.

The laboratory work during the Occupation period, 1942-1945, was principally concerned with the preparation of substitutes for antimalarial oils, motor fuel, lubricants, paint oils and oils for soap making, the basic materials used being oils from rubber seeds and from the distillation of raw rubber. The Assistant Soils Chemist was in charge of a rubber-oil factory on the outskirts of Kuala Lumpur which was estimated to be capable of producing 1,000 gallons daily of substitute anti-malarial oil.

All work ceased on soil profile analysis in connection with the survey of Malayan Soils, and all other lines of laboratory research work were discontinued. No advisory service to rubber estates was maintained, either by visits or by correspondence.

For the period of the occupation all normal activities of the Soils Division were suspended, except for the small amount of recording work done on experimental areas, and the staff of the Division were mainly employed on projects for relieving some of the oil deficiencies which were being experienced.

C. G. AKHURST,
Head, Soils Division.

KUALA LUMPUR.
May 1947.

REPORT FOR THE PERIOD

JANUARY 1941 – AUGUST 1945

BOTANICAL DIVISION

Part I—January-December 1941

Mr. C. E. T. Mann, Head of the Division was absent on military duties for one week in May and from 2nd December to the capitulation. He acted as Director during the temporary absence of the Director from 21st January to 30th May, 1941.

Dr. E. D. C. Baptist was absent on military duty for one week in May, for a period of nearly two months in September and October and from 2nd December, 1941 until the capitulation.

Mr. N. Wright proceeded on long leave on 31st March and returned to Malaya on 9th August. He was absent on military duty during September and October and from 2nd December until the capitulation.

Dr. R. Scott Russell was absent on military duties for one week in May and from 30th September until the capitulation.

Mr. K. N. Kaimal returned from long leave on 1st May. Mr. T. V. Vaidyanathan went on long leave on 1st May and returned to duty on 9th August.

In the following sections the progress is described of those parts of the experimental work which came to an end with the Japanese invasion. Those experiments which were revived after the re-occupation will be described in the Report for the years 1946-48.

I. Vegetative Propagation

(1) Method of Propagation and Planting

Experiment No. 1

This experiment, described in detail in the Annual Reports for 1939, pp. 83-85, and 1940 pp. 38-39, was designed to compare the effects of different degrees of root pruning and treatment with growth substance (Hortomone A) on the growtb of budded stumps of Hevea.

For the first six months the rate of growth of the treated stumps with lateral roots pruned at 0, 1 and 3 inches was greater than that of the untreated stumps. After that the growth in length of the untreated stumps increased and eventually caught up that of the stumps treated with Hortomone A.

Girth measurements taken at 40 inches above the union in June 1941 ($2\frac{1}{2}$ years after treatment) showed a small but not statistically significant difference due to Hortomone treatment of stumps with lateral roots pruned at O and 1 inch.

The best growth had been made by stumps with lateral roots pruned at 3 and 6 inches, which derived no benefit from the Hortomone A treatment.

The beneficial effect of Hortomone A treatment on the percentage survival of the transplanted stumps decreases with increasing length of lateral roots pruned at 3, 6 and 12 inches from the tap root.

The position 18 months after transplanting was as follows:—

Length of Lateral Roots (inches)	Percentage Survival	
	Treated	Untreated
0 ..	92	32
1 ..	90	70
3 ..	96	90
6 ..	90	96
12 ..	96	98

(2) Stock-Scion Relationship in Buddings

The experiments in this section fall into three groups:

Clonal seedlings as stocks

Experiments with twinned seedlings

High-budding experiments

The experiments were tapped throughout the year but all yield records have been lost. It was noted at the time that the results agreed with earlier observations; neither the vigour of growth of the stock nor its yielding capacity appears to have any effect on the scion. On the other hand, the evidence to show that the characters of the scion affect the stock accumulates.

(3) Growth and Yield of Budded Trees

The records of only three of these experiments have survived and the yields of these have been calculated for the whole year from the yields recorded from January to July (Table I). There is a general tendency for the yields to drop in 1941 and this can probably be mostly attributed to estimating the yields for the whole year from the lower-yielding half year. It will be noted that clone D.65 after a slow start is maintaining a satisfactory rate of increase in yield.

II. Tapping Investigations

All but three of the experiments undertaken in 1940 were continued in 1941 and five new experiments, numbers 9, 10, 49, 60 and 61 were started during the year.

At the time of the invasion 37 experiments were in progress on estates and seven on the Experiment Station. These were in the charge first of Mr. E. R. Guest and later of Dr. R. Scott Russell.

Most of the detailed records have been lost but fortunately the summarised results up to September of many of the Experiments have survived.

(1) Comparison of Tapping Systems on Seedling Trees

"A.B.C." Tapping on Mature Seedlings—Experiments 21-26

This experiment was intended to investigate the response to periodic rests of fields of mature rubber of different yield levels. Experiment 21 was abandoned during the second year when it became clear that the yields were so irregular that no information could be got from it. During the third year the yields of the other five experiments were erratic owing to the differences in the tapping history and the composition of the bark tapped. If the experiments had lasted the full five years as was originally intended, it is probable that these irregularities would have been smoothed out, but since they were discontinued at the outbreak of war there is no object in producing the results here.

Full-Spiral, double-cut (two half-spirals) and Single half-spiral tapping on seedling trees. Tapping Experiment No. 47, R.R.I.E.S., Field 6

This experiment was continued in the modified form adopted early in 1940 but all records for 1941 have been lost.

TABLE I. *Summary of Yield Records of Budded Trees on the R.R.I. Experiment Station*

Tapping System S/2, d/2, 100%

Field No.	Area in acres	Description of Field	Clone	Tappable Trees %						No. of trees 1941	Yield in lb. per tree per year 160 tappings						* W.D. % to end of 1940	† B.B. % to end of 1940
				1936	1937	1938	1939	1940	1941		1936	1937	1938	1939	1940	1941		
17A	10	Planted October 1929. Clones budded in succession December 1930. Interplanted April 1930 with unselected seedlings. Original stand 180 trees per acre in equal proportion of buddings and seedlings: Stand reduced in 1937 to 125 per acre (86 buddings and 39 seedlings). Age at commencement of tapping January 1936, buddings 5 years, seedlings 5¾ years.	Av. 50	10	34	50	67	75	77	104	3.1	3.8	5.3	6.2	6.5	5.4	—	0.2
			Av. 183	9	29	37	51	59	67	92	6.4	7.7	9.1	9.7	8.7	9.3	1.4	—
			Av. 185	18	48	65	73	76	78	109	8.0	8.1	8.8	8.7	7.7	8.1	3.6	—
			Gl. 1	26	44	57	68	71	76	110	6.4	7.6	9.2	10.0	9.2	7.6	—	4.8
			Tj. 1	51	63	68	82	87	89	116	6.7	9.3	12.7	16.7	14.9	10.6	8.1	0.1
			Tj. 16	16	39	52	62	73	78	104	6.4	7.4	8.3	9.3	7.7	5.8	—	—
			Sdlgs.	79	100	100	100	100	100	384	3.2	4.9	5.4	6.6	7.7	9.3	1.8	0.9
17c	4.8	Planted October 1929. Interplanted with stumps November 1930. Budded October 1931. Stand 180 per acre in equal proportions of Av. 50 and D.65. Reduced to 120 trees per acre in 1940. Age at commencement of tapping January 1938. 6¼ years.	Av. 50			48	68	76	80	237			3.5	4.9	6.0	8.0	0.6	—
			Pil. D.65			56	64	77	81	246			3.7	6.5	9.0	11.9	0.3	0.3
17DS	10	Planted October 1929. Clones budded in succession April 1931. Interplanted April 1930 with unselected seedlings. Original stand 180 per acre in equal proportions of buddings and seedlings. Stand reduced in July 1938 to 125 per acre, 75 buddings and 50 seedlings. Age at commencement of tapping January 1937, buddings 5¾ years seedlings 6¾ years.	Av. 50		23	41	53	63	65	82		3.7	3.8	5.6	7.2	7.2	—	—
			Gl. 1		21	30	45	58	65	81		6.1	6.7	7.5	9.9	8.6	1.5	—
			R.393		24	37	50	56	66	68		2.9	3.4	5.4	8.3	9.1	—	—
			S.24		22	36	50	59	61	70		4.0	4.8	7.7	9.4	9.4	—	—
			Tj. 1		45	50	64	70	73	89		7.2	7.1	9.5	14.4	14.3	2.0	0.6
			Tj. 16		17	28	36	43	47	56		6.5	6.3	8.2	10.2	8.8	0.7	—
			Sdlgs.		70	84	91	92				3.6	4.4	6.7	6.0	7.1	0.7	0.2

* W.D. = Trees damage by wind. † B.B = Trees affected with Brown Bast.

(2) Comparison of Tapping Systems on Budded Trees

Section A—Large-Scale Experiments

Experiments conducted on a large scale correspond fairly closely to normal estate practice, particularly those in which each plot consists of a full tapping task. Valid estimates of tapping costs can be made from experiments of this type, though their size makes it impossible to compare more than a few tapping systems in any one experiment.

Only a few of the records of the 1941 results can be traced and these are to be found in Table II. The records for experiments 1, 2, 3, 4, 5, 41 and 42 are lost.

Tapping at 67% Intensity

B.D.5 in Experiment 6 still continues to show no benefit from the periods of rest, though the other clones all respond to rest periods by yielding in excess of the relative tapping intensity.

In this Experiment B.D.5 also shows itself to be unsuited to a daily periodic system though the other clones show a rather higher yield than the control.

Tj.1 shows a similar response to full-spiral tapping to that of the previous year, but B.D.5 and the mixed P.B. clones give very much poorer relative yields.

Section B—Small-Scale Single-Task Experiments

Two more experiments Nos. 9 and 10 were tapped for the first time and the available yield results and those from the older experiments are given in Table III.

Tapping at reduced intensity. Systems 2-5 in Table III

Tj.1 and B.D. 5 in Experiment 46 show good responses to the rest during wintering and only a very small loss in crop. In Experiment 34 the results are much poorer and show no benefit from the rest. Experiment 46 is set up on a part of the R.R.I. Experiment Station with a deep coarse sandy soil with poor water-retaining capacity. The effects of wintering would probably be more marked than on the estate where Experiment 34 is carried out.

On the 67% tapping systems, all clones show a relative yield in excess of their tapping intensity. In this respect the yields of B.D.5 are very different from those obtained in the large-scale Experiment No. 6 (Table II).

TABLE II. *Comparison of Different Tapping Systems on Budded Trees—Large-Scale Experiments*

Summary of Results by Tapping Systems, 1941

Experiment No.	Experimental Tapping System	Clone	Yields 1941		Relative Tapping Cost of Experimental Systems	Previous Results	
			Control lb. per acre	Experimental System as % of Control		No. of years of Experimental Tapping before 1941	Mean Yield of Experimental System as % of Control in 1941
7	S/2, d/2, 6m/9, 67%	Tj.1	1,067	72	93	1	72
6	-do-	B.D.5	828	60	112	1	64
33	S/2, d/3, 67%	Mixed P.B. Clones	526*	84	80	2	82
33	S/3, d/2, 67%	-do-	526*	83	120	2	77
7	S/2, d/1, m/2, 100%	Tj.1	1,067	115	87	1	112
6	-do-	B.D.5	828	87	115	1	87
33	-do-	Mixed P.B. Clones	526*	109	92	2	102
6	S/1, d/4, 100%	B.D.5	828	102	—	1	132
7	-do-	Tj.1	1,067	120	—	1	129
33	-do-	Mixed P.B. Clones	526*	88	81	2	109

* Yields for 6 months, January to June only.

In all experiments the Control plots were tapped S/2, d/2, 100%.

TABLE III. *Results of "Single-Task" Tapping Experiments*

Yield of Dry Rubber: Yield of Control (S/2, d/2, 100%) expressed as pounds dry rubber per tree.
Yield of other tapping systems expressed as relative yield (percentage of control).

Girth Increment : Girth increment above the tapping panel in control system expressed in centimetres.
Girth increment above the tapping panel in other tapping systems expressed as relative girth increment.

Index No.	Tapping Systems	Yield of Dry Rubber								Girth Increment*						
	No. of Experiments:—	8		9	10	34		46		8	9	10	34		46	
	Clones:—	Tj. 1		G. 1	P.B. 186	B.D. 5		B.D. 5		Tj. 1	G. 1	P.B. 186	B.D. 5		B.D. 5	
	Year of Experiment:—	First	Second (6 mths.)	First (6 mths.)	First (6 mths.	First	Second	First	Second (6 mths.)	First (15 mths.)	Nil	Nil	First (14 mths.)	Second (12 mths.)	First (12 mths.)	Second (14 mths.)
		lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	cm.			cm.	cm.	cm.	cm.
	Control System:—															
1.	S/2, d/2, 100% ..	8.5	4.3	5.1	2.4	4.5	6.3	7.4	5.0	5.3			4.7	5.8	7.3	3.4
	Tapping at Reduced Intensity:—															
2.	S/2, d/2, 10m/12, 83% (rest during wintering) ..	93	82	71	65	87	86	96	84	94			89	106	110	118
3.	S/2, d/2, 6m/9, 67% ..	76	83	68	74	69	75	79	78	113			102	94	124	111
4.	S/2, d/3, 67% ..	70	74	74	75	81	87	76	89	107			102	90	113	123
5.	S/3, d/2, 67% ..	73	71	72	—	68	69	76	—	115			114	110	123	—
	Daily Periodic Tapping:—															
6.	S/2, d/1, m/2, 100% ..	121	121	—	100	106	119	118	115	79			87	76	90	109
7.	S/2, d/1, m/1.5, 133% ..	—	—	—	—	—	—	144	122	—			—	—	87	104

	Full-Spiral Tapping:—															
8.	S/1, d/3, 133% ..	173	154	—	135	157	173	155	169	50			55	57	67	74
9.	S/1, d/3, 3m/4, 100% ..	134	141	—	—	122	149	119	133	61			72	62	74	84
10.	S/1, d/3, 4m/6, 89% ..	—	—	99	99	—	—	—	—	—			—	—	—	—
11.	S/1, d/4, 100% ..	149	127	116	116	146	172	135	155	43			55	58	63	71
12.	S/1, d/4, 10m/12, 83% (rest during wintering) ..	126	95	—	68	127	152	126	121	45			55	62	68	71
13.	S/1, d/4, 6m/8, 75% ..	—	—	100	—	—	—	—	—	—			—	—	—	—
	Change-over and double-cut systems:—															
14.	S/3, d/1, 2d/3, (2 x 1½d/3), 89% ..	—	—	111	—	—	—	—	—	—			—	—	—	—
15.	S/2, d/2, (2 x 2d/4), 100% ..	160	137	114	122	—	—	108	134	70			—	—	90	67
16.	S/2, d/2, 2 x 7m/14), 100% ..	105	119	—	108	97	119	—	—	100			98	87	—	—
17.	2S/3, d/3, 89% ..	—	—	104	—	—	—	—	—	—			—	—	—	—
18.	2S/3, d/2, 133% ..	—	—	121	—	—	—	—	—							
19.	2S/4, d/2, 100% ..	114	116	100	—	—	—	116	—	89			—	—	93	—
20.	2S/4, d/1, m/1.5, 133% ..	150	154	—	132	—	—	—	—	76			—	—	—	—
	Significant Difference %:— (P = .05) ..	9.7				10.2		11.6		14.0			13.7		15.9	

* Since it was necessary to make the initial girth measurements before the experiments were laid out the time covered by these records does not coincide with the experimental years. The interval of time (in months) between the measurements is therefore shown.

Daily Periodic Tapping (Systems 6 and 7 in Table III)

The increase in yield of Tj.1 and B.D.5 recorded in the first year has been maintained during the second. P.B.186 shows no increase in yield.

Full-spiral Tapping (Systems 8-13 in Table III)

The increased yields from full-spiral tapping have been well maintained in the second year and in Experiments 34 and 46 on B.D.5 have even increased.

Change-over and Double-cut Systems (Systems 14-20 in Table III)

Systems 15, 16 and 19 are at 100% intensity and all show an increase in yield over the control. Of these the highest yields were obtained from system 15 in which the two half-circumference cuts were tapped on alternate tapping days. The double-four, system 19, gave lower yields but it would be expected that the cost of tapping would be slightly lower than in system 15.

Effect of Tapping System on Rate of Growth

Table III shows very clearly that the increases in yield have been acquired at the expense of the rate of growth. There is a suggestion, however, that the amount of retardation diminishes after the first year of tapping even though there is no corresponding decline in yield. This is well illustrated by the figures for the full-spiral tapping systems in Experiment 46.

(3) Tapping-cum-Manuring Experiments

Up to the end of the third tapping year no effect of the manures could be detected. Past experience with manuring experiments would not lead one to expect any effect on yield from manures within so short a time as three years.

(4) Miscellaneous Tapping Experiments

Tapping of the mature budded trees of the Pilmoor Clones

Experiment 37, Pilmoor Estate

The tapping of Clones B.84 and D.65 was continued throughout the year. New tapping cuts were opened at 40 inches from the union and the trees were tapped on the eight year old renewed bark of the tapping panel opened in January 1933. The yields which are given in Table IV have been estimated for a whole year of 160 tappings from the yields recorded from January to October.

One of the four trees of D.65 was affected with brown bast and was rested from July to the end of the year. The trees of B.84 which have been tapped daily in alternate months (S/2, d/1, m/2, 100%) yield 13.1 lbs. or 73 per cent of the yield of the trees tapped alternate-daily (S/2, d/2, 100%).

The records of the other experiments reported in previous years in this section cannot be traced.

The majority of the tapping experiments described above were set up on estates with the co-operation of the proprietors and managers.

Tapping experiments are essentially "long-term" experiments and to be of value they must be continued without interruption for a long period of years. The majority of these experiments had been in tapping for less than three years at the time of the Japanese invasion, after which all continuity was lost and the tapping became too irregular for the experiments to have any value. There would now be no object in reviving them, even if this were possible.

It is a matter of great regret that after so much time and labour had been expended on setting up these experiments they should be forcibly brought to an end before more than a small part of the results of the work could be obtained. There is however one compensation and that is the recollection of the willing co-operation and assistance that we invariably received from the managers and staff of the estates on which most of the experiments were conducted. Without this co-operation none of these estate experiments could have been undertaken.

III. Selection and Breeding

The yields of the more important clones in the clone collection are given in Table V. Most of the clones have shown a steady increase in yield during the five years that they have been in tapping. One clone P.B.123, differs from the others in making small increases in yield during the first four years but a big increase in 1941. This increase coincides with the opening of new tapping panels throughout the field in 1941.

Breeding Investigations

As a consequence of the poor results obtained from hand pollination in 1939 and 1940 a large part of the programme of crosses was devoted to increasing the size of the families

TABLE IV. *Yield of the Original Buddings of Pilmoor Clones B.84 and D.65*

Clone ..	B.84 (16 Trees)							D.65 (4 Trees)						
Year ..	1935	1936	1937	1938	1939	1940	1941	1935	1936	1937	1938	1939	1940	1941
Year of Life ..	11th	12th	13th	14th	15th	16th	17th	11th	12th	13th	14th	15th	16th	17th
Yield in lb. per tree per annum ..	19.2	21.5	17.7	19.4	21.1	20.9	18.0	23.2	23.0	17.6	21.2	22.0	21.6	11.0

TABLE V. *Yields from the Clone Collection (R.R.I. Experiment Station Field 15 North)*

Clone	Yield in lb. per tree									
	1937		1938		1939		1940		1941	
	Clone	Av. 50	Clone	Av. 50	Clone	Av. 50	Clone	Av. 50	Clone	Av. 50
	Clones from Clone Collection									
Av. 150 ..	6.1	3.1	9.0	4.4	11.4	5.4	13.4	6.6	16.8	8.1
Av. 163 ..	5.3	2.5	9.2	3.7	12.0	5.5	15.3	7.0	16.1	8.4
P.B. 24 ..	4.6	4.3	7.2	5.5	9.6	4.4	9.5	5.2	12.4	4.9
P.B. 31 ..	6.1	3.2	6.1	4.5	9.8	5.7	10.7	7.6	13.9	8.0
P.B. 49 ..	5.8	3.5	8.8	4.4	12.0	6.4	13.3	7.4	13.3	7.0
P.B. 86 ..	6.2	3.8	9.2	6.1	9.0	4.5	11.5	5.1	15.4	8.1
P.B. 123 ..	9.1	3.1	9.6	5.4	12.0	5.0	12.7	7.7	17.2	9.0
P.B. 155 ..	7.1	2.8	9.8	4.4	9.9	3.9	10.8	5.7	12.3	6.2
P.B. 183 ..	3.8	3.1	5.8	4.0	8.7	3.9	10.5	5.7	12.1	6.8
Dj. 1 ..	3.6	2.8	6.2	5.0	9.0	7.1	11.2	9.3	10.2	10.8
P.E. 26 ..	7.1	2.3	10.0	4.8	12.0	5.9	11.1	4.9	13.0	6.3
B.R. 2 ..	2.9	2.9	6.1	6.1	8.6	7.9	8.8	9.3	9.2	11.1
Lun. N ..	7.4	3.9	9.0	3.9	10.5	6.0	11.9	7.5	15.3	8.2
R.A. 22 ..	9.2	2.9	10.7	4.5	13.8	4.4	12.7	5.7	14.0	7.2
R.A. 23 ..	10.1	3.8	10.0	5.9	14.0	7.4	11.2	7.4	11.6	9.2
Pil. B. 16 ..	4.4	3.6	8.0	5.0	9.7	5.0	11.1	7.1	10.3	7.6
G. 11 ..	5.2	2.4	6.8	4.4	9.2	5.2	10.0	6.0	11.2	6.9
K. 80 ..	5.4	3.3	8.1	4.3	9.1	5.0	10.1	6.1	11.1	7.0

Note: The yields for 1941 are estimated for the whole year from the records for January to July which are the only ones that have survived.

of legitimate seedlings obtained during those years. This in effect meant concentrating on those crosses which had proved in the past to be the most infertile. The 2,690 pollinations made in repeating the old crosses produced 54 fruits, a success of 2.0 per cent. Better results were obtained with the new crosses, families 15 to 24, in which 105 fruits, 6.8 per cent, were raised from 1,533 pollinàtions.

A record of the pollinations made will be found in Table VI.

Mass Production of Hand Pollinated Seeds

As in the two previous years a large family of legitimate seeds was raised by mass pollination between clones Tj.1 and P.B.86. Altogether 10,023 pollinations were made which yielded 364 fruits (3.6 per cent). Five Indian boys were employed who each averaged just over 100 pollinations a day. Since the trees were small no scaffolding was required and this reduced the expenses considerably, the final cost working out at cents 6-7 for each germinated seed.

Legitimate Seedling Families obtained by Hand Pollination

All the yield records for the seven series of hand pollinated seedlings raised during the years 1928-1931 have been destroyed and only the summaries remain. It was noted that there was a general drop in yield during the first half-year particularly in the first three series in which new tapping panels had been opened. Three families however did show an increase in yield over the previous years, namely A.44 x B.84 in Series 1, A.44 x Lun. N. in Series 3 and B.84 x Gl.1 in Series 7.

Legitimate Seeds from 1939 Crosses

The 234 legitimate seeds obtained in 1939 were planted in a replicated trial in Field 38.

Clones of the " R.R.I. 500 " Series

The recording of the yields of these clones was not resumed until 1946. The yield records for 1941 are incomplete.

New Clones from 1939 Crosses

At the time that the legitimate seedling stumps of the 1939 crosses were planted the tops were cut off and used as budwood. In this way 165 new clones were budded for testing on a small scale in Field 38 at the Experiment Station.

New Clones from Illegitimate Seedlings of High-yielding Budded and Seedling Trees

New clones were made from 154 seedling trees growing

TABLE VI. *Results of Hand Pollinattions 1941*

Family No.	Cross	No. of Pollinations	No. of fruits Harvested	% Success	Total Seeds Planted	Total Seeds Germinated	% of Germination
1	Tj.1 x 500	176	8	4.5	24	23	95.8
2	Tj.1 x 506	180	14	7.8	42	42	100.0
3	B.84 x 509	50	—	—	—	—	—
4	Tj.1 x 509	212	15	7.1	45	43	95.5
5	Tj.1 x Lun. N	116	2	1.7	6	6	100.0
6	Tj.1 x 523	197	4	2.0	13	13	100.0
7	Tj.1 x 524	109	2	1.8	6	6	100.0
8	Tj.1 x 525	311	4	1.3	12	11	91.7
9	525 x Lun. N	153	—	—	—	—	—
10	526 x Lun. N	462	—	—	—	—	—
11	527 x Lun. N	94	—	—	—	—	—
12	528 x Lun. N.	387	—	—	—	—	—
13	529 x Lun. N	191	2	1.0	6	3	20.0
14	Lun. N x 529	52	3	5.8	9		
15	500 x 514	32	4	12.5	12	24	66.6
16	514 x 500	87	8	9.2	24		
17	514 x 501	104	11	10.6	33	33	100.0
18	505 x 514	200	25	12.5	75	51	68.0
19	505 x B.84	205	6	2.9	18	10	55.5
20	505 x Lun. N	258	16	6.2	48	38	79.2
21	507 x 501	93	—	—	—	—	—
22	514 x 506	139	17	12.2	51	48	94.1
23	Tj.1 x 512	127	2	1.6	6	6	100.0
24	514 x Lun. N	245	16	6.5	48	47	97.9
	Total	4,243	159	3.7	478	404	84.5

in various fields at the Experiment Station and these were budded in Field 38. The mother trees of these clones were partly clonal seedlings and partly seedlings from high-yielding estate trees from which seeds were collected in 1931.

Yields of Illegitimate Seedlings of High-Yielding Clones

The records for the second half of the year cannot be found, and the yields given for 1941 in Table VII have been estimated from the results of the first seven months tapping.

The yields of the seedlings of P.B.49 are outstanding, but it is probable that the soil in Field 25(4) is more fertile than in the other three fields.

Seedlings from Isolated Seed Gardens

The yields from the Tjikadoe seedlings for the first six months were summarised but the records cannot be traced. The trees were tapped on new tapping panels opened on renewed bark in January. It was noted at the time the yields were summarised that there was a general drop in yield as a result of opening new cuts at the top of the tapping panel. There was a considerable variation in the response of the different families, 6 and 22 showing a small increase in yield whereas family 11 dropped by 70 per cent.

The yields of the seedlings from the Batu Kawan I.S.G. will be discussed in a later report.

IV. Physiological Investigations

Nutrition: Pot Culture Experiment

The study of growth and leaf characters of buddings of clone Tj.1 grown in controlled sand cultures was continued during the year. This experiment was described in earlier annual Reports.

The main leaf symptoms observed are described below:—

Series B, Nitrogen deficient

The leaves of the nitrogen-deficient plants were pale yellow-green and much reduced in size. The older leaves were invariably scorched at the apical region; the scorch later extending up the leaf margins, in some cases midway up the leaf. The dead margins curled upwards and over the upper surface of the leaf.

The plants were stunted and terminal growth and lateral branching were much restricted.

TABLE VII. *Yield of Illegitimate Clonal Seedlings in various Fields on the Experiment Station*

Family	Field and date of planting	No. of Trees in tapping 1941	Yield in lb. per tree per annum 160 tappings						
			1935	1936	1937	1938	1939	1940	1941
Pil. A.44 ..	Field 4(A)	148-157	5.8	8.0	9.8	11.8	13.3	12.3	10.9
„ B.58 ..	April 1929	Records lost	4.6	6.4	8.3	10.5	12.7	12.0	—
„ B.84 ..		„ „	5.6	8.2	11.6	15.8	19.9	19.1	—
„ B.16 ..		8	2.7	5.3	6.3	7.4	12.1	10.6	8.6
Pil. A.44 ..	Field 16(N)	61	3.8	5.9	8.8	9.2	12.8	13.0	10.9
„ B.58 ..	November 1929	67	2.9	5.0	7.5	7.5	11.2	11.2	9.5
„ B.84 ..		144	4.0	7.0	10.5	11.0	15.8	16.6	13.2
Pil. A.44 ..	Field 16(S)	27	3.6	5.6	8.8	8.7	12.0	12.3	9.8
„ B.58 ..	April 1930	19	3.0	5.0	8.7	7.3	12.5	13.5	9.8
„ B.84 ..		9	2.5	5.2	9.0	7.2	12.8	11.4	10.9
„ B.16 ..		39	2.5	4.8	8.1	7.4	11.6	14.3	9.8
„ D.65 ..		50	2.3	3.6	6.7	7.7	12.3	12.9	11.1
P.B. 8 ..	Field 25(IV)	22	—	—	6.4	10.1	8.5	11.2	13.6
„ 24 ..	December 1931	20	—	—	5.3	8.1	6.9	8.6	8.8
„ 49 ..		18	—	—	7.7	11.8	10.4	17.6	20.3
„ 86 ..		37-39	—	—	6.5	10.7	9.6	13.8	18.8
S.R. 9 ..		29-30	—	—	6.4	10.6	9.4	15.6	16.5
Sab. 24 ..		16	—	—	5.9	9.6	9.0	14.8	15.9
Glen. 1 ..		22-24	—	—	3.2	5.3	5.2	8.8	10.5
Pil. D.65 ..	Field 17(DN)	18-19	—	—	—	4.4	6.3	7.7	6.7
P.B. 24 ..	November 1932	15	—	—	—	5.5	7.9	7.2	8.1
„ 25 ..		32	—	—	—	5.1	7.8	7.1	7.8
Glen. 1 ..		32	—	—	—	3.8	5.9	6.0	6.6
Sab. 24 ..		97-108	—	—	—	5.0	6.3	7.2	7.3
S.R. 9 ..		92-98	—	—	—	5.5	7.5	7.6	7.5
AVROS 50 ..		16	—	—	—	2.3	4.0	4.1	4.1
„ 49 ..		21	—	—	—	3.4	4.6	4.0	4.0
„ 152 ..		20-23	—	—	—	4.9	6.1	7.2	6.1

Yields in 1941 estimated from the yields of the first 7 months tapping.

Series C. Phosphorus deficient

The plants in this series were very similar in growth to those of Series B. Both terminal and lateral growth were restricted.

The leaves which were relatively small and narrow had scorched tips and were dull green becoming bronzy or purple with age.

The purple tints first developed between the veins and gradually spread over the whole leaf surface. In a few cases the pigmentation had spread all over one half of the leaf while it was making its appearance intervenally on the other half.

Small terminal leaves also showed these purple tints.

Series D. Potassium deficient

Growth in this series was only slightly restricted compared with the fully manured control.

The leaves were of normal size and developed intervenal chlorosis and 'tip burn' with age.

Marginal scorching and die back of shoots were not observed in this series. It is possible that the potash present in the well developed stocks of the buddings planted as budded stumps was adequate for the normal development of the plants during the period of observation.

Furthermore the possibility that the plants were able to absorb small quantities of potassium from the highly micaceous sand used as planting medium cannot be ignored.

Series E. Calcium deficient

The best growth was obtained in this series.

A mild type of intervenal chlorosis was observed on some older leaves which in some cases had a few isolated dead patches on the margins. The dead tissue usually dropped out of the leaf.

Series F. Magnesium deficient

Growth was slightly restricted compared with the control series. The characteristic symptoms observed consisted of a yellowing of the leaves, the green colour persisting only along the veins.

Necrotic spots which made their appearance in the chlorotic areas between the veins gradually enlarged and coalesced forming large patches of dead tissue.

Premature leaf abscission was common and some lateral branches were often bare of leaves.

Analytical Procedure

Carbohydrate determinations were carried out during the year on leaf samples of different age groups from the various treatments in this experiment.

The sugars were estimated by means of the Harding and Downs copper reduction method as modified by Vanderplank after extensive preliminary trials on Hevea leaves had shown the method to be suitable for this material.

Three estimations were made on each sample: (1) before inversion, (2) after inversion with normal sulphuric acid and (3) after fermentation with baker's yeast.

The above was the first of a series of analyses which was to have included nitrogen, phosphorus, potash, magnesium and calcium in the leaf materials sampled.

Treatment with Palm Oil for the Stimulation of Bark Renewal in Hevea

The first experiments in this series described in this Journal Vol. 9, No. 1, July, 1939, p.40-50, showed that as a result of the palm oil treatment the three-months-old renewed bark was on the average 0.8 mm. thicker than the untreated bark. This result was statistically highly significant.

Measurements taken $2\frac{1}{4}$ years after treatment showed no increase in the rate of growth of the treated bark but the greater thickness gained during the first 3 months had been maintained.

At 3 to $3\frac{1}{2}$ years after treatment the difference in the thickness of the treated and untreated bark had become less than half a millimetre.

The bark measurements will be found in the following table.

Effect of Palm Oil treatment on the rate of Bark Renewal

	Mean Bark Thickness in Millimetres					
	3-4 mths.	27-28 mths.	31-32 mths.	36 mths.	41-42 mths.	45-46 mths.
Experiment I, Series 1						
With Palm Oil ..	5.32		6.38			6.73
Without Palm Oil ...	4.50		5.53			6.20
Difference ..	0.82		0.85			0.53
Experiment I, Series 2						
With Palm Oil ..	4.78	6.12			6.48	
Without Palm Oil ..	3.99	5.31			6.03	
Difference ..	0.79	0.81			0.45	
Experiment II						
With Palm Oil ..	4.72	6.13		6.50		
Without Palm Oil ..	3.77	5.20		6.06		
Difference ..	0.95	0.93		0.44		

About 70 per cent of the total thickness of the renewed bark is normally obtained during the first year and it is interesting to note that the stimulation of the rate of renewal is greatest during the same period.

It will be necessary to complete the full bark cycle of seven years before the effect of the treatment on rate of renewal and yield can be determined.

Experiments were started on three estates to test the effect of palm oil on the stimulation of bark renewal and a note on the first results is given below:—

Estate A

Budded trees of four clones were included in an experiment to ascertain whether the stimulation of bark renewal is due to growth substances contained in the palm oil or to the physical effects of the oil layer.

The four treatments consisted of red palm oil, bleached palm oil (i.e. red palm oil minus carotene), paraffin oil and untreated control.

Data from this experiment are not available.

Estate B

This experiment was set up on 14-years-old budded trees with hard bark and inadequate renewal. The trees which were growing on hilly land were tapped alternate-daily on a half-spiral cut.

The difference between treated and untreated bark after 12 months' renewal was 0.65 mm. This result was significant at the 5% level. The thickness of the renewed bark, calculated as a percentage of virgin bark, was 69.4 and 57.8 for the treated and untreated bark respectively.

There was no difference between weekly and fortnightly applications of palm oil.

Estate C

This experiment was set up on 30-years-old trees with good bark and foliage on a well-drained coastal clay soil. The trees were tapped alternate-daily on a V cut.

The following conclusions may be drawn from this experiment (1) that palm oil applied to one arm of a V cut does not affect growth of bark above the other arm; (2) that the response to oil in the second half year by treated half-panels is significant at the 5% level; (3) that the difference

TABLE VIII. *Treatment of Hevea Seeds with Growth substances*

Treatment	Months from Date of Planting:—									
	1		4		7		10		13	
	% survival	Av. height (ins.)	% survival	Av. height (ins.)	% survival	Av. height (ins.)	% survival	Av. height (ins.)	% survival	Av. height (ins.)
Azeta (50 : 50) ..	95.5	10.5	91.3	18.0	89.8	27.1	89.2	40.7	89.2	56.5
Hortomone A (1 : 320) ..	75.1	8.5	74.0	15.0	70.6	25.7	70.6	39.0	70.6	57.5
Seradix A (strength E) ..	44.5	8.8	40.8	14.5	39.6	23.6	39.3	36.0	39.3	49.7
Tap water (control) ..	91.3	9.1	84.2	14.5	83.4	23.5	82.3	36.9	82.3	52.5

in growth at 6 months and at 12 months between treated and untreated panels is small (1/3 mm.) but significant at the 5% level; (4) that there is an unexpectedly small but highly significant correlation between girth and thickness of 12 months' renewal (r = 0.26 with 235 degrees of freedom) the bark thickness being on the average 0.017 mm. thicker for each increase of one inch in girth.

The response to palm oil treatment was not expected to be high in this experiment on well-grown trees with adequate renewal of the tapped bark.

Treatment of Seed with Growth Substances

Germinated Hevea seeds were treated with three proprietory growth substances and planted out in nursery beds on the Experiment Station.

The soil was a poor sandy loam and 265 seeds were used in each treatment.

The percentage survival and growth data are given in Table VIII.

The most important results of the treatments are on the survival rate of the plants and this is statistically highly significant ($P<.001$).

The increase in survival rate brought about by treatment with Azeta just fails to reach significance at the 5% level while the decrease due to Hortomone and Seradix treatments is highly significant.

Early growth of the seedlings was hastened by Azeta treatment and this advantage had been maintained 13 months after planting.

The growth rate in the Hortomone treatment was equal to that of the control plants up to the third month when it gradually increased and caught up with the Azeta treatment as shown in the table.

Seradix treatment failed to improve the growth rate of the seedlings which was actually less than that of the control plants when the last series of measurements was made 13 months after planting.

Stimulation of Yield in Hevea

Experiments were carried out on two estates to investigate the effect on the stimulation of yield by scraping the bark below the tapping cut both with and without the application of vegetable oils.

In these experiments light scraping (grooming) consisted of the removal of the other layers of cork to a distance of 12 inches below the cut and heavy scraping the removal of cork and outer cortical layers resulting in the exposure of bark parenchyma and the exudation of latex.

Preliminary yields were recorded on three consecutive tapping days before the treatments were applied. The yield from each experimental block was collected separately at weekly intervals during the first month and at fortnightly intervals thereafter.

ESTATE A

A randomised block experiment with seven replications was set up on six tasks of old seedling rubber. The treatments were light scraping and no scraping with and without one application of red palm oil and linseed oil.

Mean yields in grammes per tree for a period of 59 tapping days, adjusted by regression on preliminary yields, are tabulated below:—

Treatment	No Oil	Red Palm Oil	Linseed Oil	Difference due to	
				Red Palm Oil	Linseed Oil
Light scraping ..	1,444	1,571	1,499	+ 127	+ 55
No scraping ..	1,078	1,276	1,269	+ 198	+ 191
Difference ..	+ 366	+ 295	+ 230		

Standard error ± 61.2

ESTATE B

Factorial experiment with interactions partially confounded and balanced on three tapping tasks of old seedling rubber on peat soil.

The treatments consisted of light scraping, heavy scraping and no scraping with and without one application of red palm oil to one foot of bark below the tapping cut.

Mean yields in grammes per tree for a period of 68 tapping days adjusted by regression on preliminary yields are given below:—

Treatment	No Oil	Red Palm Oil	Difference due to oil
No scraping ..	768	976	+ 208
Light scraping ..	1,513	1,739	+ 226
Heavy scraping ..	590	584	—
Difference due to:			
Light scraping ..	+ 745	+ 763	
Heavy scraping ..	− 178	− 392	

Standard error ± 77.03

The results from both experiments show that:—

(a) Light scraping has produced very highly significant differences in yield ($P<.001$).

(b) Heavy scraping is highly detrimental to yield (Estate B).

(c) Differences due to oils are significant at the 5% level.

(d) The response to oils is not detectably different in presence or absence of light scraping.

(e) The difference between linseed oil and palm oil (Estate A) is not statistically significant.

(f) The biggest response is obtained as a result of one application of palm oil to lightly scraped bark below the cut. Increased yields of 1.1 lb. per tree (Estate A) and of 2.1 lb. per tree (Estate B) were obtained during the period of four months after treatment.

(g) A rapid increase in yield of over 80% (Estate A) and 150% (Estate B) recorded at the end of the first month gradually declined and was back to normal (Estate A) and about 20% above normal (Estate B) at the end of four months.

(h) A second treatment, six months after the first, of light scraping and palm oil on Estate A caused an increase in yield of 30% which fell to normal after three months.

It remains to be seen whether the yield could be stimulated at regular intervals without permanent harm to the trees.

Until more is known of the permanent effects of these treatments, the use of scraping and vegetable oils should be confined to those fields which it is intended to replant.

V. Ecological Studies

Cultivation of Rubber Trees in Association with Leguminous Covers R.R.I. Experiment Station, Field 27

No changes were made in the five treatments which are detailed below.

I. Natural Covers—A. Minimum control. Lalang, stag-moss, and bracken removed. Jungle trees out-topping the rubber cut back when necessary. No other treatment until May, 1939, when half of each plot was

slashed to ground level and planted with *Centrosema pubescens*.

II. Natural Covers—B. Slashed every 6 months to 3 feet. Lalang, stagmoss, bracken and Blechnum eradicated.

III. Natural Covers—C. Similar to II, but all ferns removed.

IV. Leguminous shrubs with *Desmodium ovalifolium* and *Clitoria cajanifolia* planted above and below the terraces.

V. Leguminous creepers.

Regular tapping, S/2, d/2, 100%, commenced in July, 1940, and was continued up to the end of 1941, though the yields to the end of August only are available. These are tabulated below.

Cultivation Experiment. (R.R.I.E.S., Field 27)

Treatments	Yield in lb. per acre	
	July-December, 1940	January-August, 1941
I	217	344
II	238	368
III	235	384
IV	216	357
V	226	364

The differences in yield are small and probably without significance.

VI. New Field Experiments on the R.R.I. Experiment Station

A stock experiment was set up on 23 acres in Field 43. Eleven types of stock were used, including *Hevea Spruceana* and six types of seed obtained from special trees growing on Bahau Estate, Dunlop Plantations Limited. These trees were grown from seed obtained from trees at the Botanic Gardens, Buitenzorg, which in turn were grown from a special importation of seeds from Brazil.

Field 38, 53 acres, was budded with a large-scale trial of Clones R.R.I. 523 to 529 and a small-scale trial of clones made

from the 1939 hand-pollinated seedlings and illegitimate seedling trees growing on the Experiment Station. A trial to compare the 1939 crosses with a budded control was also set up in the southern part of the field.

VII. Field Experiments on Estates

Of the five clone-trial experiments set up in 1940, one was budded before the end of the year, and arrangements were made for budding the remainder in 1942.

The first sets of girth measurements were taken in three of the density-of-planting experiments, and the first thinning-out of the most densely-planted plots of one experiment was completed.

Arrangements were made for setting up three new experiments for testing the R.R.I. clones on a total area of 82.5 acres of replanted land.

VIII. Advisory

An analysis of the correspondence of this Division will be included in an appendix to the Director's report. Owing to the absence from their estates on military duties of many planters, there was a reduction in the number of letters received and despatched. Most of the letters were concerned with advice on the choice of planting material, and requests for budwood of the R.R.I. clones.

The following Circular and Advisory Leaflets were prepared during the year:—

Circular No. 13, "Practical Notes on Full-Spiral Tapping."

Advisory Leaflets:

B/AL. 15. "Pruning of Young Budded Trees of Clone Pilmoor B.84."

B/AL. 16. "Instructions for Test-Tapping and Thinning out."

B/AL. 17. "Planting of Promising New Clones on Estates."

Visits were paid to estates by all members of the staff in connection with experimental and advisory work, but no record of these visits can be traced. Nor can any record of the lectures given to Planting Associations be found.

Publications

1. Experiments with Economic Tapping Systems (3) Tapping-cum-Manuring Experiments on Young Mature Rubber Trees. Part I, Evan Guest, *Journal of The Rubber Research Institute of Malaya*, Vol. 10, Communication No. 253.
2. Full Spiral Tapping, R. S. Russell, *Journal of The Rubber Research Institute of Malaya*, Vol. 11, Communication No. 254.

Part II—January 1942-August 1945

The greater part of the information contained in Part II is taken from a report submitted by Mr. K. N. Kaimal and Mr. T. V. Vaidyanathan.

Staff

After the capitulation at Singapore on 15th February, 1942, Mr. C. E. T. Mann, Dr. E. D. C. Baptist, Mr. N. Wright, and Dr. R. Scott Russell remained in Malaya as prisoners-of-war until late in 1945.

Mr. C. C. T. Sharp left Singapore on 13th February 1942 and was appointed temporary Botanist to the Rubber Research Scheme, Ceylon, from 16th April 1942 until the end of the period under review.

General

The Japanese troops occupied Kuala Lumpur during the first half of January 1942, but the staff were unable to enter the laboratories until early in February when permission to do so was obtained from the Japanese authorities. In the intervening period the laboratories were badly looted, much apparatus was damaged or stolen and many of the experimental records were destroyed, either completely or in part. All the staff who were in Kuala Lumpur returned to duty and did all they could to repair the damage. The apparatus which survived was cleaned and repaired where possible. The ledgers containing the yield records of the field experiments had been thrown on the floor and severely damaged by water. These were collected and copied except those for Experiment Station Fields 2, 4A, 9A and 16 which were so severely damaged as to be illegible. This work took a considerable time and was not completed until 1943. This voluntary effort on the part

of the staff during a period of nearly a month, in spite of the risks and the dangerous conditions which prevailed at the time, is mentioned with appreciation.

In the middle of March, Mr. K. N. Kaimal was appointed officer-in-charge and instructed to reopen the Institute and a skeleton staff was appointed to the Division under the charge of Mr. Vaidyanathan. By May, the whole staff of the Division had been re-engaged except for those who had resigned in 1941, whose return was forbidden by the Japanese.

Japanese officers took charge of the Institute in December 1942 and Mr. K. N. Kaimal was appointed Deputy Director in charge of the Botanical and Pathological Divisions and the Experiment Station.

This arrangement was continued until 1944 when Mr. Kaimal was permitted to resign and Mr. Vaidyanathan was transferred to the Experiment Station to take charge of a course of training for estate staff. They were replaced by Japanese officers.

The programme of work of the Division was altered by the Japanese and the following investigations were undertaken:

1. Experiments on the preservation of fruits and vegetables by dipping them in compounded latex, preserving them in rubber bags etc. None of these experiments proved successful.

2. Cultivation of castor oil plants in the Institute's grounds and at the Experiment Station and the collection and preparation of the seed for milling.

3. The preparation of vegetable dyes from indigenous plants and the dyeing of green and brown khaki cloth in the laboratories.

4. The extraction of vegetable fibres from the bark of many species of forest trees, pineapples, Manila hemp etc. Small-scale manufacturing was undertaken of rope, twine and canvas belting of one inch to fifteen inches width. Samples of a coarse textile were also produced.

5. Experiments on the production of yeast from toddy were carried out under the direct supervision of Japanese officers and starch and glucose were prepared from tapioca.

Work of the Division Relating to Rubber

As described above the work of the Division was changed after the appointment of Japanese officers to take charge of

the Institute but none the less it was found possible to continue some of the work on rubber.

The greatest difficulty experienced was in maintaining tapping in the field experiments both at the Experiment Station and on estates and although in the remainder of this report many experiments are referred to as being tapped, the tapping was so irregular that it has been concluded that the yields recorded would be misleading and they have not, therefore, been reproduced.

I. Vegetative Propagation

(1) Budding Technique

Various substitutes for bandage cloth were tried and the fibrous bark of a jungle tree was found to be a satisfactory substitute. This was used for budding in the nursery over 8,600 seedlings which were required for a hedge planting experiment.

(2) Stock-Scion Relationship in Buddings

Experiments under this section were continued. The tapping of Fields 14E(i), 4C, 25(iii), 22B and 10 was resumed between April and June, 1942. Owing to shortage of labour Fields 14E(i) was not tapped after May 1943. All the other fields were tapped until the time of the surrender.

(3) Growth and Yield of Budded Trees

Tapping of the proved clones established in Fields 5, 10, 17A, 17D(S), 21 and 22A was resumed between April and June 1942. Fields 17A and 22A were not tapped after May 1943. The other fields were tapped and yields recorded up to 1945.

Field 14C and D, Density-of-Planting Experiment, was tapped from April 1943 to 1945.

II. Tapping Investigations

(1) Tapping Experiments at the R.R.I.E.S.

All tapping experiments which were in progress in 1941 at the Experiment Station except for those in Fields 19, 22A and 25(v) were resumed between April and June 1942 and tapped until the time of the Japanese surrender.

(2) Tapping Experiments on Estates

There were 37 tapping experiments in progress in 1941 on different estates, of which 17 were in Selangor. With the co-operation of the estate staffs all the experiments in Selangor were resumed by June 1942. Regular recording of yields was continued as before and everything seemed to be satisfactory for some months. But from 1943 onwards many difficulties arose in the conduct of field experiments. As a result of various suggestions made to the estates to enable them to maintain a satisfactory standard of tapping they managed to continue the experiments throughout 1943. But by 1944 the estates informed the Institute, one by one, of their inability to continue the tapping experiments and nearly all came to an end by December 1944.

III. Selection and Breeding

(1) New Clones from Estate Mother-Trees—Field 15(S)

Tapping the 235 new clones commenced in July 1942 and was discontinued in March 1943.

(2) Clone Collection—Field 15(N)

Tapping and yield recording commenced in April 1942, but was discontinued in May 1943.

Breeding Investigations

A small programme of crosses by hand-pollinations of three clones of *Hevea brasiliensis* by *Hevea spruceana* was undertaken in August 1942. The results are summarised below:

Cross	No. of Pollinations	No. of fruits Harvested	% of Success	No. of Seeds Planted	No. of Seeds Germinated	Germination %
P.B. 86 x H.S. ..	302	3	1.0	9	8	88.9
R.R.I. 505 x H.S. ..	352	4	1.1	12	8	66.7
R.R.I. 501 x H.S ..	240	14	5.8	37	37	100.0
	894	21	2.3	58	53	91.4

The seeds were planted in the nursery. It was intended to make buddings of these crosses in the nursery and transplant the buddings and the mother-trees to a plot to be prepared adjacent to Jungle Block A in the Sungei Buloh forest reserve. A contract was given for clearing and preparing 7 acres of jungle and felling started in the middle of 1944 but the work was abandoned and the contractor disappeared

before half of it was completed. Nothing further could be done and the crosses were left in the nursery.

Legitimate seedlings from 1940 crosses and new clones from them

Fourteen families obtained from hand-pollination in 1940, consisting of 412 seedlings were planted as stumps in Field 45, R.R.I.E.S. in November 1942. From 13 families 192 clones were made and established in Fields 41 and 42 in November 1942.

Legitimate Seedlings from 1941 Crosses

Hand-pollinated seedlings of the 1941 crosses numbering 355 were stumped and planted in Field 45B during October-November 1943.

Legitimate Seedlings 1928-31 and the New Clones established from them

All trees in these experiments which were in tapping in 1942 were brought into tapping again between April and June 1942 and yield recording continued as before. Tapping was continued until August 1945.

Illegitimate Seedlings of High-Yielding Clones

Tapping and yield recording of the more important illegitimate seedling families in Fields 4A, 16N, and S, 17D(N), and 25(iv) were resumed in April 1942 (the last named field in June) and continued until the time of the surrender.

Seedlings from Isolated Seed Gardens—Field 2

The twenty-five families of seedling trees grown from the Tjikadoe isolated garden seeds in Field 2 were tapped from April 1942 and the usual recording continued. In May 1943 all trees except those in the "test-tapping" experiment were rested.

IV. Physiological Investigations

Nutrition: Pot-Culture Experiments

By February 1942 all rubber plants in this experiment had died from lack of watering.

Investigations under this section were not resumed.

V. Ecological Studies

Cultivation of Rubber Trees in Association with Indigenous Plants and Leguminous Covers—Field 27

The wires and posts demarcating the plot-boundaries and transects for detailed botanical surveys were looted and surveys were not made during 1942-45. The experimental treatments were continued and carried out regularly except for the omission of the two rounds of slashing which were due late in 1944 and early in 1945.

General observations were continued and a full account of the progress of this experiment is being prepared as a separate publication.

VI. Field Experiments on the R.R.I.E.S.

In 1942 much of the Sungei Buloh Forest Reserve land was allotted to squatters for food production, and it was felt necessary that the Government nursery adjoining the Experiment Station should be transferred to the R.R.I. to prevent it from being given to others. Most of the area was then allotted to the Experiment Station labourers for food crop cultivation.

An application was then made to the Forest Department to alienate that land permanently to the Experiment Station for a hedge-planting experiment and for the cultivation of food crops. At the same time another application for the alienation of forest reserve previously applied for or for an assurance that it would be reserved for the Experiment Station was also made. Both the applications were approved by the Japanese authorities.

A plan was designed for a hedge-planting experiment similar to that prepared in 1940 for setting up on estates under the Rubber Regulation Scheme. An area of 65 acres was surveyed and prepared in 1942 and planting was completed in April 1943. Food crops—ragi, tapioca, and gingelly—were cultivated in rotation between the hedges of rubber trees during 1942 and 1943. Yields then became very poor and uneconomic, except on the low-lying areas on both sides of the stream, and the high-lying areas were in consequence abandoned by the labourers. In 1944 the low-lying areas were used for the cultivation of ragi and the rest of the area was planted with castor oil seeds. Germination was very poor and the few plants which developed were later attacked by insect pests and many died. Finally the crop harvested was only a few gantangs

of seeds. Lines of banana plants were planted between the rows of rubber trees in October/November 1943.

VII. Field Experiments on Estates

The continuation and the care and maintenance of field experiments already established in 1941 was one of the important items in the programme of work of the Division, prepared for the duration of the Japanese occupation.

As soon as the Institute was re-opened and work resumed a list of the field experiments, the object of the experiments and the estates where they were conducted, was prepared.

Most of the estates requested a visit by a member of the Institute's staff, but owing to the difficulties of travelling the majority of their problems had to be dealt with by correspondence.

Copies of schemes of the experiments and details of routine work for the care and maintenance of the experiments were prepared and forwarded to the estates where the records had been looted. All the estates promised their co-operation.

As transport facilities improved the field-staff visited the estates, took girth measurements and made reports on the condition of experiments.

Unfortunately, budding due in 1942 and 1943 could not be undertaken.

In November 1943, Perlis, Kedah, Kelantan and Trengganu were ceded to Siam and the Institute lost control over the experimental areas established in those States. Early in October, just before the cession of those States, Mr. Kaimal visited the experimental areas in Kedah and Province Wellesley and reported on the condition of the experiments at the time. He was promised by the estate staffs concerned that everything possible would be done to maintain the experiments even after the estates were handed over to Siam.

VIII. Advisory Work

Correspondence

No analysis of the correspondence during the period 1942-45 is possible since the files are missing. Correspondence decreased progressively from 1942 to 1945. Most of the correspondence dealt with the care and maintenance of experimental areas and tapping experiments on estates.

PUBLICATIONS

(1) Circular No. 14, 1942. Economic Production of Rubber and Management of Rubber Estates under Present Conditions. (Section on Botanical problems).

(2) Circular No. 15, 1942. Care and maintenance of Budded Rubber Trees.

(3) Circular No. 18, 1942. Cover Plants and Incidence of Stem and Panel Diseases of Rubber (Section on Cover Plants).

ESTATE VISITS

All records of visits are lost.

Visits to estates and experimental areas were generally made by Field Assistants and Rubber Instructors stationed at the Institute. The Experiment Station was visited regularly at least twice a week until January 1945 by either Mr. Kaimal or Mr. Vaidyanathan.

VISITORS

After the re-opening of the Institute Japanese Military officers and others used to visit the laboratories in parties almost daily. Owing to the interference with the work caused by these visits a museum was opened to divert visitors from the Divisions, but this did not have the desired result and visitors continued to come until the end.

Many members of estate staffs visited the Division for advice.

C. C. T. SHARP,
Head, Botanical Division.

KUALA LUMPUR,
May 1947.

REPORT FOR THE PERIOD JANUARY 1941—AUGUST 1945

PATHOLOGICAL DIVISION

The present writer did not assume duty as Head of the Division until after the period covered by this report. He has therefore been compelled to depend for his information largely on documents compiled by other hands; and on such of these as have survived the vicissitudes of war and of four years of enemy occupation. In these circumstances the incompleteness of the record will call for no further comment.

Part 1—January - December 1941

In 1941, the graduate staff of the Division consisted of three senior officers, Mr. F. Beeley, Head of the Division, Mr. R. P. N. Napper, Pathologist, and Mr. L. D. E. F. Vesey Fitzgerald, Entomologist, and one Asiatic graduate assistant, Mr. K. P. John, Assistant Pathologist. Periods of embodiment in units of the F.M.S. Volunteer Force, or, in the case of Napper, of duty with the Selangor Medical Auxilliary Service, seriously hampered the professional activities of the senior officers during the year, and their work in the Division was finally brought to a close by the order for general mobilization which came into force on 1st December.

It is to be recorded with deep regret that two of these officers, Beeley and Napper, lost their lives as a result of the war. Napper was killed on the 14th February, 1942, during the attack by enemy aircraft on the s.s. "Tien Kwang" in the waters of the Linga Archipelago; and Beeley died of dysentery on the 30th June, 1943, at Hindatio in Siam, whilst a prisoner of war. By the untimely death of two such experienced pathologists the Institute and the rubber industry have suffered a heavy loss. For more than a decade their investigations had covered every disease and pest known to affect the rubber tree in Malaya, and between them they had acquired an unique store of knowledge. Beeley will be remembered not only for his pathological researches, but also for his original studies in the field of latex bacteriology; and Napper, in particular, for his elucidation of the complex problem presented by the diseases of the root-system—an achievement whose results provide the basis for the modern approach to the control of root disease in tropical plantation crops.

Diseases of the Root System

Experiments on Estates. (a) Experiments laid down before 1941

Observations on the six field experiments laid down by Napper to study the control of root disease in connexion with replanting were continued. Two of these experiments (B.K. 1 and H. 1) had been started in 1937, three (B.K. 2, H. 2, and L.P. 1) in 1938, and the remaining one (G. 1) in 1940. Three rounds of collar inspection and treatment were carried out in the five older experiments during the year, and there is some evidence (found in correspondence of the Occupation period) that the first round of inspection and treatment was completed on G. 1 in December.

Of the original records, only those relating to the results of the three rounds on H.1, B.K.2, L.P.1 have been preserved. The missing data for B.K.1 have, however, been recovered from the field note books, which, by a fortunate chance, were still in the possession of the assistant who had supervised the work. The inclusion of figures for H.2 has been made possible by the existence of a table analysing the results of the year's observations, but no data concerning G.1 can be traced.

Labour difficulties which arose during the course of the year began to have an adverse effect on the comparative value of the cost data. In the case of experiment H.2 it was, in Napper's words, "necessary to employ a large gang of unskilled labourers in place of the trained gang previously available. The work was reasonably well done, and the incidence figures are reliable. Cost figures, however, are strongly biased, being abnormally high in the plots first treated."

In accordance with previous practice only a representative selection of the results available from these experiments will be published in this report. To enable comparisons to be made between figures of cost for successive years (despite an increase in wages in 1940 and again in 1941), the relevant data are presented in the form of 'man-days' in all the tables which follow.

Experiment B.K.1 (Inland District)

This experiment was laid down in 1937 in an area where the old stand was heavily infected with root-disease, due mainly to *Ganoderma pseudoferreum*.

Lay-out. Six treatments replicated five times. Total area 80 acres.

Pre-planting treatments

A. Plots dug over to a depth of 18 inches and all roots removed.

B. As A, but the depth of digging restricted to 10 inches.

C. Disease patches dug to a depth sufficient to remove all infected roots. Remainder of the area dug to 10 inches without collecting roots.

D. Disease patches treated as in C, but the rest of the area not dug. The larger roots of healthy trees removed by felling with jack or grubber.

E. No systematic digging. Diseased trees eradicated individually, and all infected roots followed up and removed. Healthy trees treated as in D.

F. No digging or stump removal. All trees cut off at ground level and the stumps injected with sodium arsenite.

Ground Covers. One half of each plot was planted with a creeping leguminous cover, the other half with an erect leguminous cover.

Post-planting treatment. Standard treatment based on periodic tree-to-tree collar inspection.

For further information concerning this experiment reference should be made to the Annual Reports for 1937 and subsequent years.

The results obtained up to the end of 1941 are summarized in Tables I to III.

Table I shows the incidence of infection up to the end of the fourth year after replanting. The figures for *Ganoderma pseudoferreum* make it quite clear that stump-poisoning is an inadequate substitute for digging when it comes to the question of dealing with the sources of infection present in the old disease patches, for they show that the total number of cases of disease due to this fungus which had occurred in the stump-poisoned plots (treatment F) was now more than double that recorded in any treatment other than B (incomplete eradication).

The relative distribution of the total incidence of disease caused by *Fomes lignosus* in the six treatments remained unchanged. Reference to Table Ia shows that there was, however, a variation in the trend of its *annual* incidence, and the absence of any noticeable decline in the number of cases of diseases due to *Fomes lignosus* in treatment F over a period of four

TABLE I. *Experiment B.K.1. Incidence of root-disease up to the end of the fourth year after planting*

Treatments	Fomes lignosus			Ganoderma pseudoferreum			Fomes noxius			Ustulina zonata			Totals		
	R	B	T	R	B	T	R	B	T	R	B	T	R	B	T
A	63	20	83	45	48	93	14	26	40	5	11	16	127	105	232
B	85	29	114	64	76	140	9	40	49	10	19	29	168	164	332
C	123	44	167	26	64	90	18	46	64	5	38	43	172	192	364
D	142	40	182	29	49	78	18	38	56	4	12	16	193	139	332
E	146	56	202	33	52	85	13	40	53	3	19	22	195	167	362
F	103	44	147	67	122	189	8	36	44	3	6	9	181	208	389
Totals	662	233	895	264	411	675	80	226	306	30	105	135	1,036	975	2,011

R = Number of infected rubber trees (including both dead and partially infected trees).
B = Number of groups of bushes killed by root disease, excluding those associated with infected rubber trees.
T = R + B.

years raises the question whether the early promise shown by this method of control was being maintained.

TABLE Ia. *Experiment B.K.1. Incidence of infection (rubber trees and groups of bushes) due to Fomes lignosus, year by year up to the end of the fourth year after planting.*

Treatments	No. of cases due to F. lignosus				
	1st year 1938	2nd year 1939	3rd year 1940	4th year 1941	Total
A ..	10	29	20	24	83
B ..	14	60	24	16	114
C ..	17	67	46	37	167
D ..	35	78	48	21	182
E ..	26	100	45	31	202
F ..	15	51	40	41	147

Reference to the figures of cost given in Table II shows that E held its place as the most economical treatment. The high cost of the post-planting treatment in F, due to the presence of the old stumps, was even more marked than in the previous years, the expenditure per point treated now being almost double that in E and D.

Table III shows the incidence of infection and cost of treatment under bush covers and creeping covers respectively. These figures continue to emphasize the fact that any favourable influence that bush-covers may have on the incidence of disease in the rubber is outweighed by the high cost of treatment among the bushes themselves.

EXPERIMENT H.1 (COASTAL DISTRICT)

For full details of the treatments and lay-out of this experiment, and discussion of the first three years' results, reference should be made to the Annual Reports for 1937-1940.

The data obtained up to the end of 1941 are summarized in Table IV.

No explanation can be offered for the general increase in incidence of disease in 1941 compared with 1940. Treatment D (complete eradication of infected roots from the old disease patches, and stumps of apparently healthy trees jacked out) was still clearly the cheapest and most effective of the four treatments compared. The failure of treatment A (digging

TABLE II. *Experiment B.K.1. Costs of treatments per round and per year to the end of the fourth year after planting (in man-days per acre, excluding cost of supervision)*

Year	Round	Wages per diem	Treatment													
			A		B		C		D		E		F		Means	
1st (1938)	1st	45 cts.	3.22		8.84		5.47		8.11		6.64		20.18		8.74	
2nd 1939)	2nd	45 cts.	5.89		12.98		8.89		17.67		10.38		24.22		13.34	
	3rd	„	3.75	14.22	4.16	26.01	7.58	23.80	5.29	33.34	8.71	28.60	14.18	56.16	7.28	30.36
	4th	„	4.58		8.87		7.33		10.38		9.51		17.76		9.74	
3rd (1940)	5th	50 cts.	4.38		6.12		4.36		3.90		5.56		7.58		5.32	
	6th	„	4.12	12.12	5.52	19.06	7.92	15.20	7.40	15.78	5.86	15.36	7.16	22.70	6.33	16.71
	7th	„	3.62		7.42		2.92		4.48		3.94		7.96		5.06	
4th (1941)	8th	55 cts.	3.64		3.35		3.18		3.07		3.56		8.62		4.24	
	9th	60 cts.	3.00	9.24	5.07	10.64	4.02	10.22	3.15	8.14	2.52	8.03	10.23	21.70	4.67	11.34
	10th	„	2.60		2.22		3.02		1.92		1.95		2.85		2.43	
Totals since planting ..			38.80		64.55		54.69		65.37		58.63		120.74			
Pre-planting (1937 Wages 45 cents) ..			159.69		91.51		112.87		98.98		55.80		22.84			
Grand Totals ..			198.49		156.06		167.56		164.35		114.43		143.58			

TABLE III. *Experiment B.K.1. Incidence of infection and comparative costs (in man-days) of root-disease control in creeping-cover and bush-cover areas since planting (excluding cost of supervision)*

Round	Wages per diem	Creeping-cover areas (rubber trees only)		Bush-cover areas					Cost of Inspection	Total Cost	Cost per acre
				Rubber trees		Bush groups		Total Cost			
		Incidence	Cost	Incidence	Cost	Incidence	Cost				
1st	45 cts.	73	204.51	56	134.87	224	306.11	440.98	54.00	699.49	8.73
2nd	„	105	437.58	74	265.13	168	298.33	563.47	66.00	1,067.04	13.33
3rd	„	66	206.00	53	122.51	103	198.51	321.02	54.98	582.00	7.27
4th	„	59	291.67	47	198.89	99	222.78	421.67	65.55	778.89	9.73
5th	50 cts.	51	150.50	51	146.50	37	62.00	208.50	66.00	425.00	5.32
6th	„	46	110.62	52	140.30	162	190.48	330.78	65.04	506.44	6.34
7th	„	46	170.30	30	79.30	39	75.10	154.40	76.50	404.20	5.06
8th	55 cts.	43	123.51	27	45.00	94	60.00	105.00	110.49	339.00	4.24
9th	60 cts.	48	138.00	42	88.00	32	31.00	119.00	116.00	373.00	4.67
10th	„	26	39.00	39	46.50	17	6.50	53.00	102.00	194.00	2.43
Total incidence ..		**565**		**471**		**975**					
Total cost ..			**1,874.69**		1,267.00		1,450.81	**2,717.82**	776.56	5,369.06	
Cost per acre ..			23.43		15.84		18.14	33.97	9.71		67.11

to 18 inches) to show any superiority over treatment B (digging to 9 inches) continued, as did the high incidence of disease in treatment C (digging to 18 inches in three annual stages). It was evident that treatments A and B were uneconomic, and that treatment C was both costly and ineffective.

The lack of success attending treatment A is rather surprising. It may be that uniform digging to 18 inches in a peat soil left too many infected roots undisturbed for the treatment to show any marked effect. It is to be remembered that in treatment D the depth of digging in the disease patches was limited only by the depth to which infected roots could be traced.

Experiment B.K.2 (Inland District)

This experiment was started in 1938 as a small supplement to B.K.1, and was designed to compare treatment F (stump-poisoning) in the latter experiment with a control in which the stumps were left untreated. Three ground-cover treatments (bushes, creepers and no cover) were superimposed. There were three replications of the clearing treatments and six of the cover treatments, the total area being six acres.

Three rounds of inspection and treatment were carried out in 1940 and again in 1941. Table V summarizes the results.

The figures of incidence for *Ganoderma pseudoferreum* support the view that stump-poisoning cannot be relied upon to eliminate the sources of infection present in old diseased patches. The marked reduction in the incidence of disease due to *Fomes lignosus* up to the end of the second year after planting (1940) in the stump-poisoned plots is worthy of attention, for the effect is comparable with that obtained in experiment B.K.1.

Experiment H.2 (Coastal District)

The preparation of this experiment was completed, and the area planted, by the end of 1938. Each of the four pre-planting treatments was replicated nine times, the plot unit being one acre. For details of the treatments and an account of the purpose of this experiment reference should be made to the Annual Report for 1938. A discussion of the first two years' results will be found in the Annual Report for 1940, pp. 95-98. The results up to the end of 1941 are summarized in Table VI.

TABLE IV. *Experiment H.1. Incidence of root disease and cost of treatment year by year up to the end of the fourth year after planting*

Treatments	Incidence of disease					Costs in man-days per acre					
	1st year 1938	2nd year 1939	3rd year 1940	4th year 1941	Totals	Preparation 1937	1st year	2nd year	3rd year	4th year	Totals
A. Digging to 18 in. ..	33	13	6	13	65	163.75	2.44	5.09	3.86	5.32	180.46
B. Digging to 9 in. ..	31	9	12	15	67	82.64	3.20	4.29	6.59	6.44	103.16
C. Digging to 18 ins. in 3 annual stages ..	58	35	14	17	124	38.46	22.49*	40.60*	6.38	6.82	114.75
D. Standard eradication in disease patches. Healthy trees jacked out	16	17	7	19	59	25.40	3.51	8.80	4.80	8.32	50.83
Totals ..	138	74	39	64	315						

* Includes cost of strip-digging.

TABLE V. *Experiment B.K.2. Incidence of infection up to the end of the third year after planting*

Treatment	Year	Fomes lignosus					Ganoderma pseudoferreum				
		No Cover	Creeping Cover	Bush Cover	Totals		No Cover	Creeping Cover	Bush Cover	Totals	
Stumps poisoned ..	1940	1	3	0	4	7	2	2	6	10	15
	1941	0	1	2	3		2	3	0	5	
Stumps Untreated ..	1940	4	8	3	15	16	4	1	1	6	9
	1941	0	0	1	1		2	1	0	3	
	Totals	5	12	6			10	7	7		

TABLE VI. *Experiment H.2. Incidence of infection and cost of treatment (expressed in man-days) up to the end of the third year after planting*

Treatments	Incidence of Infection				Cost of treatment (in man-days)		
	Rubber trees	Leguminous bushes	Totals	Old stumps removed	Rubber trees	Leguminous bushes	Totals
A. Frill-girdling without poison ..	127	10	137	110	793.0	44.5	837.5
B. Frill-girdling with poison ..	101	7	108	85	611.5	51.5	663.0
C. Stumps poisoned ..	103	8	111	83	641.0	45.0	686.0
D. Stumps not poisoned ..	139	12	151	124	961.5	59.0	1,020.5
Totals ..	470	37	507	402	3,007.0	200.0	3,207.0
1. Creeping covers ..	120	—	120	97	831.5	—	831.5
2. Bush covers ..	111	37	148	130	810.0	200.0	1,010.0
3. No cover ..	239	—	239	175	1,365.5	—	1,365.5

A striking increase in the incidence of disease in the frill-girdled plots (treatment A) during 1941 completely changed the aspect of this experiment, and, incidentally, raises a number of interesting questions. Leach (*Proc. Roy. Soc., B,* 121: 561. 1937) found that the susceptibility of certain forest trees to attack by *Armillaria mellea* could be reduced by exhausting the starch reserves of their roots by ring-barking their stems some time before felling. Treatment A was incorporated in this experiment in order to determine whether the liability of the rubber tree to infection by *Fomes lignosus* is influenced in a similar way by the starch content of its roots.

A comparison of the figures of incidence up to the end of the third year after planting (Table VI) suggests that, in its effect on the susceptibility of the roots of the old stumps to infection, treatment A is but slightly superior to treatment D (no treatment prior to felling, stumps untreated). It is by no means clear to what cause this relative ineffectiveness of ring-barking can be attributed; whether to its inability to hasten the death of the roots to any marked extent (Annual Report, 1940, p. 97) in spite of a reduction in starch reserves (Annual Report, 1938, p. 123), or to the fact that the pathogenicity of *Fomes lignosus* is unaffected by the starch content of its host, or to some other cause. It is equally difficult to explain why the increase in disease in the A plots (from 3.7 cases per acre in 1940 to 10.2 cases per acre in 1941) should have been so far in excess of that which occurred in the plots under treatment D. (See Table VIa below).

TABLE VIa. *Experiment H.2. Annual incidence of infection per acre up to the end of the third year*

Treatment	Number of cases per acre			
	1st year 1939	2nd year 1940	3rd year 1941	Total
A ..	0.22	3.67	10.22	14.11
B ..	0.67	5.00	5.56	11.23
C ..	0.33	5.44	5.67	11.44
D ..	0.67	6.89	7.89	15.45
Means ..	0.47	5.25	7.33	13.06

On the score of effectiveness there was little to choose between treatment B (poisoning of the standing tree) and treatment C (poisoning of the stump), but the cost figures were slightly in favour of B. The cost per point treated fell slightly but was still very high at about 6.5 man-days per point. This high cost of treatment, directly attributable to the presence of the old stumps, constitutes a serious objection to all four of the pre-planting treatments compared in this experiment.

It was again demonstrated that the incidence of root-disease is significantly lowered in the presence of a ground cover.

Experiment L.P.1 (Coastal District)

Details concerning the design and purpose of this experiment will be found in the Annual Report for 1938, p.121. There were five treatments, replicated five times, the total area being ten acres. Three rounds of inspection and treatment were carried out in 1941. The incidence figures up to the end of 1941 are summarized in Table VII.

Table VII. *Experiment L.P.1. Incidence of root disease up to the end of 1941*

Treatment	Incidence of Disease			
	1st year 1939	2nd year 1940	3rd year 1941	Total
A ..	1	8	3	12
B ..	3	5	3	11
C ..	3	8	6	17
D ..	2	4	6	12
E ..	1	2	3	6
Total ..	10	27	21	58 ..

It will be seen that the results are quite anomalous, the number of cases of disease occurring in the A and D plots (digging to 18 inches) being actually in excess of those occurring in the B and E plots (digging to 9 inches). The smallness of the experiment and the low incidence of disease, amounting to a total of only 5.8 cases per acre up to the end of the third year after planting, must be held to account for this inconsistency.

Experiment G.1 (Inland District)

This experiment was started in 1940 its object being to obtain further information on the effects of tree and stump-poisoning on the incidence of root disease in inland soils, and to compare the phytocidal properties of sodium arsenite and sodium chlorate. A description of the treatments and lay-out,

observations on the relative toxicity of the two sodium salts, and data relating to the costs of the pre-planting treatments were published in the Annual Report for 1940, pp. 98-99.

During the course of the year a round of stump inspection was carried out in order to investigate the effects of the different treatments on the rate of death of the old roots. The results of this investigation are summarized in Table VIII.

TABLE VIII. *Experiment G.1. Effect of pre-planting treatments on the viability of the stumps*

Treatment	Per cent of stumps with **some** live roots in the inspection pit	Per cent of stumps with **no** live roots in the inspection pit
A. Standing tree poisoned with sodium arsenite ..	4.5	95.5
B. Standing tree poisoned with sodium chlorate ..	56.9	43.1
C. Stumps poisoned with sodium arsenite ..	5.9	94.1
D. Stumps poisoned with sodium chlorate ..	28.0	72.0
E. Standard felling. Stumps removed	—	—
F. Stumps not poisoned ..	88.5	11.5

These figures show quite clearly that poisoning with sodium arsenite, whether of the standing tree or of the stump, accelerates the death of the roots. Sodium chlorate is seen to be less toxic.

There is evidence that one round of collar inspection and treatment was completed before the end of the year. No record of this can be found.

EXPERIMENTS ON ESTATES. (b) EXPERIMENTS LAID DOWN IN 1941

Six new replanting experiments were initiated during the course of the year. Four of these were primarily designed to study the influence of various pre-planting treatments on the incidence of root disease in the young stand. The object of the other two was to investigate the effects of different methods of post-planting control. Details of the treatments and lay-out of the one experiment (H.B.1) on which it was

possible to carry out work during the Japanese occupation will be given in the appropriate place.

In the case of a second experiment (H.B.2), a statement giving the cost of the pre-planting treatments has been found, and as this is of more than passing interest it has been summarized in Table IX below. The four treatments concerned were as follows:—

A. Standing trees ring-barked and frill-girdled. No poison applied. Trees subsequently felled above ground level.

B. Standing trees ring-barked and frill-girdled. Poisoned with sodium arsenite. Trees subsequently felled above ground level.

C. Trees felled above ground level and stumps poisoned by injection of sodium arsenite.

D. Standard felling. Stumps removed by mechanical means.

Disease patches were subjected to standard treatment throughout, all sources of infection being removed by digging. The average stand of the old trees was 65.6 per acre, and the total area 60 acres.

TABLE IX. *Experiment H.B.2. Cost of pre-planting treatments in man-days per acre*

	Cost of each operation in man-days per acre						
Treatment	Ring-barking	Frill-girdling	Poisoning	Felling	Stump-poisoning	Standard felling	Total cost per acre
A	2.55	1.77	—	55.75	—	—	59.47
B	2.55	1.77	15.1	55.75	—	—	74.57
C	—	—	—	55.75	24.98	—	80.73
D	—	—	—	—	—	77.33	77.33

It will be seen from the above table that, in this experiment, poisoning had no economic advantage over standard felling in so far as the cost of clearing was concerned. Examination of the figures brings out the interesting point that the reason for this was the high cost of felling. The trees were larger than those encountered in the previous year in experiment G.1 (Annual Report 1940 p. 99) and cost 51 cents, or 0.85 man-days, per tree to fell.

Preparation of Sodium arsenite from Local Arsenical Residues

In view of the growing popularity of sodium arsenite for use as a tree or stump poison in connexion with replanting, the possibility was examined of preparing this substance from the arsenical residues which were obtainable at certain local tin mines. These residues are a by-product of the roasting of tin ores rich in arsenical pyrites, and contain a high percentage (90 per cent and over) of arsenious oxide. Laboratory tests showed that by treatment with caustic soda or common washing soda arsenic could be extracted from the residues as sodium arsenite in almost theoretical quantities, and at a cost well below even the pre-war price of imported sodium arsenite. The methods of preparation were found to be simple and well within the scope of any normal estate, and it was considered that they would prove popular provided that the tin companies were prepared to market the residues in a form compatible with the Poisons Enactment.

A note on this subject was published in the *R.R.I. Planters' Bulletin*, and the Mines Department was approached in connexion with the marketing of the residues.

Mildew (*Oidium heveae*)

It was reported by Beeley that following the wet weather which occurred towards the end of 1940, the opening months of 1941 were drier in some districts than is usual. Wintering of the rubber foliage was early and rather severe in character. At no time during the refoliation season was a protracted period of cool, dull weather experienced, such rain as did fall being followed immediately by clear skies. Conditions were therefore ideal for the growth of the young leaves and unsuitable for the development of the fungus. Few outbreaks of *Oidium* occurred; reports being received from only 14 estates in March, and 9 in April. This was remarked on as being the lowest incidence recorded in the ten-year period since the annual returns were inaugurated. The infection was mild in all cases and confined mostly to the lower shaded branches.

A microscopical examination of the foliage of an area of rubber trees close to the laboratories, based on samples collected daily during the period of susceptibility, showed that the disease rarely appeared on the leaves, and such inflorescences as were attacked were only slightly affected.

The mildness of the 1941 outbreak made sulphur dusting unnecessary, but a few estates carried out abbreviated programmes as a routine measure.

A table, as published in previous reports, showing the rainfall for the first five months of the year in six representative districts, is given below:—

TABLE X. *Rainfall in inches*

District	Jan.	Feb.	Mar.	Apr.	May	Total for five months
Kuala Lumpur ..	6.30	5.70	14.09	12.18	11.12	49.39
Sitiawan ..	8.78	4.70	3.46	6.47	5.35	28.76
Port Dickson ..	4.07	3.36	6.40	4.21	7.44	25.48
Tampin ..	4.83	2.62	3.53	7.62	7.60	26.20
Malacca ..	6.02	6.46	2.13	6.45	7.60	28.66
Kluang ..	11.06	1.81	7.39	16.87	9.92	47.05

Diseases of the Tapping Panel

There is no information available regarding the prevalence of diseases of the tapping panel during 1941.

Leaf Diseases

With the object of determining to what extent copper fungicides could be used for the control of nursery leaf diseases, a proprietary fungicide (containing copper in the form of the oxychloride) and 5:5:50 Bordeaux mixture were tested in a small-scale trial on the Experiment Station. The former was used not only as an aqueous solution, but as a dust in combination with sulphur. The plants were sprayed, or dusted, at weekly intervals for a period of six weeks. At a concentration of 0.5 per cent in water the proprietary fungicide is reported to have given slightly better control than the Bordeaux mixture, but its effectiveness was reduced when it was used as a dust mixed with equal parts of sulphur.

Diseases of the Stem and Branches

PINK DISEASE (CORTICIUM SALMONICOLOR)

No record of the position in regard to pink disease during 1941 has been found.

BARK-BURSTS

Frequent reports of the occurrence of bark-bursts in clone B.D.5 led to an attempt to determine the cause of this complaint and to find means for its treatment. Numerous isolations made from the characteristic lesions failed to disclose the presence of a pathogen. Treatment of the bark by scraping, followed by the application of palm oil or linseed oil (a method found to improve bark renewal in seedling rubber) proved quite unsuccessful. Within three weeks of the operation, the scraped and oiled portions of the stem began in the majority of cases to exude latex profusely, and a month later most of the treated bark was reported to be dead.

Insect and Animal Pests

TERMITES

Work on the biology and taxonomy of the several species of *Coptotermes* which occur in rubber plantations was continued by Vesey Fitzgerald.

Progress was made with an investigation designed to study the phytocidal properties, in relation to the rubber tree, of a number of substances which might be of use as insecticides or repellents against white ants. The observations were made on young seedlings raised in baskets and transplanted (without removal from the baskets) at intervals of one foot in rows one foot apart. The unit plot contained fifteen plants, set out in three rows of five plants each. The substance to be tested was buried on either side of one of the outer rows of each plot, at points six inches distant from the plants. Each treatment was replicated twelve times. Records are available showing the results obtained with crude naphthalene and paradichlorbenzene. These are summarized in Table XI below.

TABLE XI. *Phytocidal Test of Repellents*

Treatment	Per cent mortality in seedlings after 6 months
Crude naphthalene. 1 oz. per point buried in a linen bag at a depth of 4″ ..	0.6
Paradichlorbenzene. 1 oz. per point buried in a linen bag at a depth of 4″ ..	56.0
Control. No treatment ..	0.6

This contrast between the lethal effects of paradichlorbenzene and the inertness of crude naphthalene is of considerable interest. The proximity of the chemicals and the immaturity of the plants helped no doubt to exaggerate any toxic tendencies; a feature which may be considered desirable in an experiment of this nature.

By placing the repellents in linen bags, which could be removed and weighed at regular intervals, it was possible to gain information regarding their durability in the soil. Whereas most of the paradichlorbenzene was found to have disappeared at the end of two months, there was a negligible decrease in the weight of the naphthalene over this period.

The insecticidal and repellent values of the various substances studied in the phytocidal tests were in the course of investigations during 1941 in a series of experiments laid down on the Experiment Station, and also on an estate where the incidence of infestation was high; and evidence that paradichlorbenzene was far more effective as a repellent than naphthalene had already been obtained before the work was brought to a close.

Experiments to compare various methods of control including the use of poison baits, repellents, and attractants, were established on two estates. Unfortunately no details of these have been preserved.

Cockchafers

Biological control by the use of natural enemies offers a promising line of approach to the problem created by the *Psilopholis* pest of mature rubber, and on this account attention was directed towards raising a stock of Hymenopterous parasites for breeding purposes. Open situations along river banks were found to be favourable places in which to search for these insects. During the course of this work a new Dipterous grub-parasite was encountered and reared. This insect was not identified.

Observations on the life-history and habits of *Psilopholis* were continued. It was found that the grubs were unable to survive in soil alone or in a mixture of soil and decomposing vegetable matter.

Trials of grub fumigants were carried out under laboratory conditions. The following substances were tested:—carbon bisulphide, petrol, crude naphthalene and paradichlorbenzene.

Carbon bisulphide was definitely lethal, the effect of petrol was somewhat uncertain, and the grubs tended to revive after treatment with naphthalene or paradichlorbenzene.

Soil injection experiments were laid down on two estates. Only such materials as were available locally could be used, supplies from abroad being unobtainable. A solution of paradichlorbenzene in petrol (4 lb.: 1 gallon) gave the best results, but even this treatment was considered to be uneconomic.

Work on the taxonomy and ecology of Malayan species of cockchafers was continued.

Giant Snail

In consequence of the prevailing scarcity of Meta fuel (metaldehyde), which had been used widely in the past for the control of giant snails, the search for a substitute was continued.

An experiment designed to determine whether Meta possessed attractant properties, and to compare it in this respect with various flavouring essences, yielded some interesting results.

The substances under test were mixed with rice bran and their attractiveness for the giant snail compared with that of the pure bran. The greatest number of snails was caught by a bait consisting of bran mixed with pineapple essence, there being no significant difference between the Meta-bran catch and that effected by pure bran.

Microbiology of Latex

A comprehensive enquiry into the subject of the spontaneous coagulation of latex was carried out during the year by Beeley. The principal object of this study was to determine the influence on coagulation of various substances which might be expected to find their way into latex cups as natural contaminants. Among the many materials examined were tapping-cut shavings, rain drips from bark, extracts of the living tissues of the rubber tree and extracts of soil. Unfortunately no detailed record of any of these experiments has survived, but from a summary of the work that has been found it seems that evidence was obtained which showed that coagulation could be induced by all of the above mentioned substances. In consequence of an observation that the activity

of the tissue extracts was unaffected by pasteurization but destroyed on boiling, it was concluded that the living tissues of the rubber tree contain enzymes which, when freed from the cell, are capable of causing coagulation.

As the outcome of a study of the rates of growth of bacteria in fresh and preserved latex, and in standard bacteriological media, evidence was obtained that fresh latex contains a growth-promoting substance, and the opinion was expressed that the extent to which bacterial growth is inhibited in preserved latices is proportional to the amount of this growth factor inactivated by the process of preservation.

Advisory Work

Visits and Interviews

Visits to Experiment Station and Smallholdings ..	110
Visits to Estates other than Experiment Station ..	114
Interviews at the Institute ..	55

Specimens Examined

Leaves	25
Roots	16
Bark	8
Stumps	13
Branches	13
Seedlings	19
Cover plants	24
Cockchafers and other insects	53
	171

Lectures

1. "Root Disease Control in Young Rubber Areas" by R. P. N. Napper. Incorporated Society of Planters, Malacca, on 12.1.41.
2. "Inoculation of Leguminous Cover Plants" by K. P. John. Estate Asiatic Staffs' Association, Kajang, on 25.1.41.
3. "Pests and Diseases of Young Rubber Areas" by K. P. John. Estate Asiatic Staffs' Association, Sungei Siput, on 26.7.41.
4. "Pests and Diseases of Young Rubber Areas" by K. P. John. Estate Asiatic Staffs' Association, Ipoh, on 22.9.41.

5. Broadcast on "Pests and Diseases of Rubber Growing" by F. Beeley, from Singapore on 1.10.41.

Advisory Leaflets

P/AL. No. 1(41)—An Alternative Method of Stump-Poisoning with Sodium Arsenite.

P/AL. No. 2(41)—Termites.

P/AL. No. 3(41)—Mouldy Rot of the Tapping Panel.

Part II January 1942—August 1945

Mr. K. P. John, Assistant Pathologist, officiated as Officer-in-Charge of the Division during the period covered by this section of the report. Much credit is due to this officer, to Mr. H. C. Chuan, the Institute's Artist and Photographer, and to the members of the Junior Staff for their efforts to preserve, in circumstances that were at times most discouraging, such records and equipment as had escaped the indiscriminate looting which took place before the Japanese Forces entered Kuala Lumpur.

For the first two years of the occupation a praiseworthy attempt was made to continue the rounds of inspection and treatment in many of the replanting experiments that had been laid down by Napper. Difficulties arising from a lack of transport and from the introduction of regulations imposing restrictions on movement tended to confine this work to areas within the State of Selangor. Subsequently, when the administration of the Institute came under yet closer Japanese supervision, the importance of these activities failed to arouse official interest and they were further curtailed.

As Malaya was now cut off from all external sources of supply of fungicidal and insecticidal materials, attention was of necessity turned towards a search for substitutes. During the third quarter of 1941, that is, just prior to the Japanese attack, work on the distillation of an anti-malarial oil from scrap rubber had been started by the Chemical Division at the request of the Health Authorities, who had feared that they might be faced with a shortage in this essential material. The approaching exhaustion of the stocks not only of anti-malarial oil but of all products resulting from the distillation of coal or petroleum led, in 1942, to a rapid expansion of this project; and, as soon as the so-called "rubber oil" began to be produced in increasing quantity, experiments to determine the

possibility of using some of its various fractions for fungicidal or insecticidal purposes were undertaken.

"Tin mine arsenic," the residue resulting from the roasting of tin ores rich in arsenical pyrites had been included among the several substances whose value as insecticides or repellants for use against white ants were in course of investigation at the end of 1941; and, since there seemed some prospect that supplies of this substance might continue to be forthcoming, these observations were maintained and extended.

Following the changes in administration of the Institute and the assumption of more direct control by the Japanese, the Pathological and Botanical Divisions were amalgamated The effect of this reorganisation was such that much of the normal work of the Division was brought to a close and its activities confined to the investigation of a number of *ad hoc* problems, few of which had any bearing on the plantation rubber industry.

Diseases of the Root System

Experiments on Estates

A table showing the rounds of inspection and treatment carried out in the replanting experiments during the period covered by this section of the report is given below.

Table XII.

Experiment	Order of Round	Year
B.K. 1 ..	11th	1942
H. 1 ..	13th	1942
	14th	1943
	15th and 16th	1944
B.K. 2 ..	7th	1942
	8th	1943
H. 2 ..	8th	1942
	9th	1943
	10th	1944
	11th	1945
L.P. 1 ..	8th	1942
H.B. 1 ..	1st and 2nd	1943
	3rd	1944
	4th	1945

The failure of estate labour to recover from its initial disorganization severely handicapped the progress of this work from the beginning. In 1942, four months were required to complete one round of inspection and treatment in B.K.1—a task which formerly occupied a quarter of that time. As the years passed, and more able-bodied men were withdrawn from the estates for forced labour in Burma and Siam, an increasing proportion of the work had to be performed by women, most of whom were unaccustomed to heavy tasks and weakened by malnutrition. The effect of these conditions was to render of doubtful value all data relating to costs compiled later than 1942, and for this reason they will be omitted from subsequent summaries. On the other hand there is nothing implicit either in the employment of female labour or in the difficulties of the times which need automatically detract from the reliability of the figures of incidence.

Experiment B.K.1

A comparison between the figures derived from the 11th round of inspection and those of the round which had preceded it by at least eight months leads to the view that a general decline in the incidence of disease due to *Fomes lignosus* was in progress in the fifth year of this experiment. An increase in the number of cases due to *Ganoderma pseudoferreum* occurred in treatments A and F.

A survey of the experimental area was made in November 1945 and many of the plots were then found to be carrying a heavy growth of grass and *belukar*.

Experiment B.K.2

The results obtained in 1942 and 1943 call for little further comment. The beneficial effect of stump-poisoning in reducing the incidence of *Fomes lignosus* in the young stand, which was evident during the first two years after planting (Table V), was no longer apparent. In the three years between 1941 and 1943, as many cases of disease due to this fungus occurred in the stump-poisoned plots as in the controls, the incidence in both being low.

Experiment L.P.1

The one round of inspection and treatment completed in 1942, which was carried out a year after the previous round, disclosed a notable rise in the incidence of infection in the

C, D, and E plots. As this has tended to alter the aspect of the experiment, a summary which includes both these figures and the cost data is given in Table XIII.

Reference to this table shows that although there had been a considerable decrease in the incidence figures for treatments A and B (uniform digging) compared with treatment C (standard felling), it is extremely doubtful whether the expenditure necessary to produce this result was justified.

No figures of cost are available for treatment C, but as the whole experimental area was first subjected to this treatment (the other four treatments then being superimposed) the absence of this information does not affect the relative values of the totals, which show treatment C to be by far the most economical. In other words, in no case had the fall in incidence and the consequent saving in the cost of the post-planting treatment been large enough to compensate for the additional expenditure incurred by the superimposed pre-planting treatments.

Before turning from Table XIII, it is worth noting that strip-digging to a depth of 18 inches (treatment D) seems to have been as unsuccessful in this experiment as it was in H.1.

Experiment H.B.1

This experiment will be discussed in a subsequent report.

Mildew (*Oidium heveae*)

The collection of information relating to the seasonal outbreaks of this disease was not possible between 1942 and 1945. There are therefore no records of its prevalence during this period.

Diseases of the Tapping Panel

Mouldy Rot (Ceratostomella fimbriata)

The latter part of 1942 is reported to have been exceptionally wet, with the result that mouldy rot became prominent both on smallholdings and on estates. The progress of the disease was favoured by the presence of uncontrolled ground covers and a lack of suitable fungicides. With the increasing neglect of the later years, conditions even more suitable for the development of the causal fungus must have obtained, but its activities were no doubt checked by the general decline in the amount of tapping.

TABLE XIII. *Experiment L.P.1. Incidence of root disease and cost of treatment in man-days per acre up to the end of 1942*

Treatment	Incidence of disease			Cost in man-days per acre		
	Total to 1941	4th year 1942	Total	Pre-planting treatment	Post-planting treatment	Total
A ..	12	1	13	108.89 + X	20.15	129.04 + X
B ..	11	4	15	52.78 + X	19.64	72.42 + X
C ..	17	10	27	X	29.30	29.30 + X
D ..	12	12	24	61.11 + X	20.41	81.52 + X
E ..	6	12	18	38.27 + X	17.27	55.54 + X
Total ..	58	39	97	X = Cost per acre of treatment C. See text.		

Rubber Oil as a Fungicide for the Control of Mouldy Rot

With the object of determining the possibility of employing rubber oil, or some of its fractions, as a substitute for the various proprietary tar derivatives normally used in the control of mouldy rot, a series of trials was carried out in 1942 on a heavily infected smallholding in Ulu Langat.

Both the crude oil and a heavy fraction suitable for antimalarial work were tested in three forms, (a) unmodified, (b) as a 40 per cent emulsion in a 1 per cent soap solution, and (c) mixed with an equal volume of palm oil. A proprietary fungicide was included in the tests for purposes of comparison. It was found that the disease could be brought under control by about ten daily applications either of the unmodified oils or of the palm oil mixtures. The emulsions were less effective, but gave a degree of control comparable with that given by the proprietary preparation. Some damage was caused to the renewing bark by the use of these oils but this was not regarded as serious.

Diseases of the Stem and Branches

Pink Disease (Corticium salmonicolor)

Outbreaks of pink disease in replanted areas carrying stands of young budded rubber were reported in 1942.

Insect and Animal Pests

Termites

Observations carried out on the Experiment Station showed that "tin mine arsenic" could be used in the field for the control of white ants as a substitute for white arsenic or Paris green.

Giant Snail

In the course of a search among locally available materials for some means of protecting plants against the depredations of the giant snail, evidence was obtained that a solution of rubber in crude rubber oil served as an effective repellant. A poison bait prepared by incorporating about 2% of "tin mine arsenic" in rice bran showed some promise.

Advisory Work

PUBLICATIONS

Circular No. 14. Economic Production of Rubber and Management of Rubber Estates under Present Conditions. (Section on Diseases and Pests). May, 1942.

Circular No. 18. Cover Plants and Incidence of Stem and Panel Diseases of Rubber (Section on Diseases). September 1942.

KUALA LUMPUR,
May 1947.

R. A. ALTSON.
Head, Pathological Division.

REPORT FOR THE PERIOD JANUARY 1941—AUGUST 1945

CHEMICAL DIVISION

Part I—January - December 1941

Staff

At the beginning of the year the established strength of the Division was four Research Officers: Mr. W. S. Davey, the Head of the Division, Messrs. J. D. Hastings, J. H. Piddlesden and V. H. Wentworth, and Mr. K. C. Sekar, the Assistant Chemist. Messrs. Piddlesden and Wentworth and several members of the junior staff were embodied in the military forces for a period of two months during the first quarter of the year.

Mr. Hastings left for England on long leave at the end of March, and was on his way back to Malaya when war with Japan broke out. On his arrival in Ceylon he received instructions not to proceed to Malaya.

No further staff changes occurred until December, when general mobilisation of the local forces took place.

During the second part of the year a large part of the time of the Chemical Division was spent in giving technical assistance to the Defence Services; research work had in consequence to be severely curtailed.

Latex

(a) Chemistry and Technology

The study of the changes which take place in the acetone extract of ammonia-preserved latex was continued. By continuing observations over a long period of storage it was found that the formation of free acids is not materially dependent on the concentration of ammonia, though there was evidence that at high ammonia concentrations (*ca.* 5 per cent NH_3 on the latex) acid formation was slightly depressed. In order to ascertain to what extent the increase of acidity which occurs on storage is attributable to the decomposition of protein, ammonia-preserved latex was stored for varying lengths of time and the usual analytical determinations were

made on the dried films. The experiments were not completed but it may be recorded that there was relatively little change in the nitrogen content of the stored film after acetone extraction, indicating that the increase in acidity on storage was not due to protein degradation.

(b) Preservation

The sodium and potassium salts of pentachlorphenol were tested as anti-coagulants for field latex, but were found to be less effective than ammonia.

Cetyl pyridinium chloride, a chemical which possesses bactericidal properties, was found to be ineffective as a preservative when used alone or with 0.1 per cent ammonia. When the ammonia content was raised to 0.2 per cent encouraging results were obtained, and plans were made for extending the trials.

With 0.2. per cent ammonia thallium salts were found to be powerful preservatives, as little as 0.01 per cent being effective. One objection to the use of thallium compounds in latex is that they impart a faint grey colour to the latex due to the formation of black thallium sulphide.

(c) Latex Discolouration

Experiments were carried out to ascertain whether latex discolouration could be prevented by adding small quantities of sodium bisulphite. It was found that five to ten pounds of bisulphite per thousand gallons of latex sufficed to prevent discolouration without materially affecting the stability of the latex; with larger amounts of bisulphite stability was reduced.

Further examination, both in Malaya and London, of latex stored in cans lined with a waxy material of American origin (Annual Report 1940 p.119) confirmed that this wax gave better protection than a latex-zinc oxide film. The investigation was not continued because of the strict control of imports from non-sterling countries.

(d) Concentration

(i) *Centrifuging*

The possibility of removing sand and sludge from field latex by centrifugal clarification was considered, and a series of trials was made with a small laboratory centrifuge. The trials indicated that the cost of this cleaning process would be high and that there would be difficulty in adapting it to

estate production because of the tendency of field latex to pre-coagulate.

In collaboration with Dunlop plantations samples of latex of clone Glenshiel I were obtained from different sources and concentrated. For reasons which were not apparent the latex was invariably found to be very unstable.

Because of the high price of rubber and the high export quota, the problem of recovering rubber from centrifuge skim was re-examined. Records of this work have been lost, but it appears that promising results were obtained by creaming the centrifuge skim latex and re-mixing the cream with fresh input latex.

(ii) *Creaming*

Further evidence was obtained that, in accordance with the views of Bondy (*Trans. Far. Soc.* 1939, **35**, 1093), adsorption is not an essential factor in promoting latex creaming, and may even be disadvantageous. When creaming agents such as gum tragacanth etc. are added to neutral fresh latex instead of to ammoniated latex, they are strongly adsorbed because of the low charge on the particles, and are thereby removed from the serum phase so that no creaming occurs. To produce creaming in neutral latex it is necessary to use an abnormally large amount of creaming agent. By contrast, the alginates, which can be shown to be not adsorbed on the particles, cause creaming whether they are added before or after ammonia.

Sulphonated lorol is a substance which is relatively highly adsorbed and is a creaming agent if used in high concentration. Creaming occurs whether ammonia is present or not, but the d.r.c. of the cream is higher when ammonia is absent. By using the methods of our colleagues of the London Advisory Committee it was possible to calculate the distribution of sulphonated lorol between the rubber and the serum phases by determining the equivalent sulphur remaining in the serum after creaming, and hence the amount adsorbed on the rubber particles. It was found that with increasing amounts of added sulphonated lorol the amount adsorbed approached a maximum (about 3 per cent of the rubber) and that creaming occurred only at the higher concentrations. It appears from these observations that the creaming agent in the dispersion medium is the predominant factor in bringing about creaming, and tnat it acts by competing for the water in the system, whereby the adsorbed layer is dehydrated by the large amount of sulphonated lorol in the serum, and the forces which maintain the rubber

particles as independent units are reduced. Large amounts of sulphonated lorol are necessary for creaming because small quantities are withdrawn from the serum by adsorption and only serve to protect the particles.

Another material which is not normally regarded as a creaming agent, but which induces creaming under certain conditions, is sodium pentachlorphenate, high concentrations of which produce good separation in unammoniated latex. Creaming is appreciably improved by the addition of soluble starch which in itself has no creaming action with ammoniated latex. Here again it is to be supposed that the starch dehydrates the surface of the particles and reduces the repulsive forces between them, so that association of particles into clusters occurs and creaming ensues.

Technological Study of Rubber

By systematically varying the conditions under which smoked sheet was prepared at the Experiment Station it was demonstrated that the rate of cure is affected by the amount of machining given to the coagulum, and also by the time of dripping, provided this time is not unduly prolonged; on the other hand the effect of using water on the rollers or of varying the time of dripping up to about eight hours is negligible. The results which might have become available from this investigation would have been a valuable source of information on the influence of variations in factory procedure on the properties of smoked sheet. Unfortunately most of the records were lost during the Occupation.

Buddings of *Hevea spruceana* on *Hevea brasiliensis* were tapped at different heights above and below the union with the object of obtaining information about the effect of stock on scion. It was found that the rubber obtained on successive tapping days varied in its content of acetone-soluble matter from about 10 per cent to as much as 40 to 50 per cent. The character of the product varied from that of a soft sticky wax to that of normal rubber. Yields were low and technological tests were not carried out.

Modified Rubber

(a) Low Water-Absorption Rubber

In 1940 encouraging reports were received from America on low water-absorption rubber which had been sent for

evaluation, and there were requests for shipments of up to 25 tons. Manufacturers suggested the addition of an anti-oxidant to prevent softening during transit or storage, and of a colour to aid identification in the factory. Both suggestions were considered to be reasonable, although there was no positive evidence that pronounced softening occurs in the absence of an anti-oxidant. No difficulty was experienced in meeting the desire for a coloured crepe, but as there was a possibility that this might lead to the rubber being classified as manufactured goods, and therefore liable to a special duty, no shipments of coloured crepe were made. A British patent was applied for during the year to cover the methods used in the preparation of this low water-absorption crepe. Because latex centrifuging equipment was fully employed in meeting the demand for latex concentrate, attempts were made to prepare commercial quantities of low water-absorption rubber by creaming instead of by centrifuging. The product obtained had good water-absorption qualities, but was nevertheless inferior to the product obtained by centrifuging. When the work ceased it was felt that the substitution of creaming for centrifuging in the process could not be recommended unreservedly. Mr. Wentworth described in the *J. Rubb. Res. Inst. Malaya* Communication 257 the methods which he had worked out for determining the water-absorption capacity of crude and vulcanised rubber, both by suspension in water vapour and by immersion in water.

(b) Softened Rubber

British Patents (B.P. 531,723; 535,837; and 536,301) for the preparation of softened rubber by the incorporation of mercaptonaphthalenes and xylyl mercaptans, benzoyl peroxide, and mercaptobenzthiazole, into latex prior to coagulation, were accepted. The specifications were published in the *J. Rubb. Res. Inst. Malaya* 1941 **11** (Comm. 259). Several small shipments of "M.B.T.-softened" rubber were prepared and sent to interested consumers, but no reports on their behaviour were received.

A proprietary product (Flexalyn, Hercules Powder Co. Inc.) consisting of diethyleneglycol abietate resin in xylene, was used experimentally for the preparation of softened rubber by mixing latex with emulsions of the resin prior to coagulation. To obtain appreciable softening, however, it was necessary to add rather large proportions of resin, and it was concluded that the method would not be commercially practical or economic.

(c) Oil-Resistant Rubber

The swelling characteristics of different rubbers were studied with particular reference to variations between rubbers of different clones. The test used to evaluate oil resistance was that of Naunton *et alia* (*Trans. I.R.I.* 1933, 9, 169), but swelling was measured by change of volume instead of by increase in the weight of the sample.

Rubber from nine clones, including P.B.186 and Tj.1 which give soft and hard rubber respectively, was tested monthly for oil absorption. The experiment was not completed and the results were inconclusive, but there were indications of a correlation between plasticity and oil absorption. The vulcanisates were compared after the same time of cure, not at the same state of cure, but their curing characteristics were not widely different.

It was found that the addition of small amounts of kapok fibre to the A.C.S. mix increased the hardness and the modulus of the vulcanisates, and consequently their resistance to oil absorption, but seriously reduced their tensile strength. The modulus appeared to be related to oil absorption in stocks of the same rubber content, and experiments were therefore made to increase modulus without loss of tensile strength. The basic chemical 4.4-dipiperidyl was found to produce high modulus and high tensile strength without reversion at prolonged cures, and a marked reduction in oil absorption. When both kapok and 4.4-dipiperidyl were combined in the same mix, the oil resistance contributed by each was found to be additive, and the tensile strength was not seriously impaired. The products thus obtained had oil absorption properties approaching those of neoprene, but neoprene had better physical properties in the swollen state. Mr. Wentworth's records of this work have unfortunately been lost, and only this brief summary of some of his findings remains.

(d) Formation of Compounding Ingredients in Rubber

Experiments on the formation of compounding ingredients in latex were prompted by a paper by Twiss, Neale, and Hale (*Trans. I.R.I.* 1940, **16**, 111). It was thought that the protein sheath around the latex particle might be an obstacle to the interaction of added chemicals with the rubber, and that it would therefore be advisable to work with de-proteinised latex. In preliminary trials barium sulphate was precipitated *in situ* with deproteinised latex. Vulcanising ingredients were added on the mill and the vulcanised product was compared with a

vulcanisate of the same composition prepared in the conventional manner. Though there was evidence of reinforcement by co-precipitated barium sulphate it was not clear whether the reinforcement was technologically significant. The investigation had to be discontinued at an early stage.

(e) Latex—Aqua Regia reaction product

The latex halogenation experiments carried out by the staff of the London Advisory Committee for Rubber Research (*Proc. Rubber Tech. Conf.* 1938, 209) were extended by studying the reaction of fresh latex with aqua regia. A note on the physical and chemical properties of the product was published in the Journal (*J. Rubb. Res. Inst. Malaya*, 1941, **11**, Comm. 258).

Estate Technique

(a) Scrap Drying Shed

The experimental scrap drying shed described in the last report (Ann. Report 1940, p.130) was found to be satisfactory. A brief description and plans were published in the *R.R.I. Planters' Bulletin*, 1941 **6** 1.

(b) Packing of Rubber

Progress was made in simplifying the process of packing bare-back bales, and in reducing the time taken to prepare them. Reports on trial shipments despatched to America were generally favourable and larger consignments were called for. As a result of the experience gained in preparing these consignments it was felt that the method advocated was satisfactory for large-scale routine operation, though the problem of storing the packed rubber without distortion of the bales could not be considered completely solved.

A trial consignment to London of R.S.S.1 in bare-back bales was criticised on the grounds that sampling was difficult and costly, and that the outer wrappers were contaminated with dirt and could not therefore be utilised as R.S.S.1. It was also contended that the cost of bare-back baling was not appreciably less than that of baling with hessian and strapping with steel bands. In reply to these criticisms it was acknowledged that there may be difficulty in sampling the bales, but the cost could not be greater than the cost of sampling the conventionally strapped hessian bales. Contamination of the outer wrapper was of small consequence

since all manufacturers have uses for lower grades of sheet. The cost of baling bare-back was estimated to be $1 to $1.10 less than the cost of baling in hessian. An account of the experiments and a description of the recommended packing procedure were in the press at the end of the year when war broke out.

(c) Smokehouses

The prototype of the R.R.I. tunnel Type C smokehouse which was described in R.R.I. Annual Report 1940, p.130, was brought into operation during the year. The results were satisfactory and the construction of a second Type C smokehouse was completed.

(d) Dirt in Rubber

There was a good response to a questionnaire on estate practice which was circulated at the end of 1940, but unfortunately all the records were lost during the Occupation. A new device for cleaning latex was designed, and arrangements were made to apply it on a factory scale at Sungei Buloh, but the work was not completed.

(e) Partitions for Coagulating Tanks

Because of the shortage of aluminium, attempts were made to construct coagulating tank partitions from thin sheet iron covered with an ebonite-bonded acid-resisting vulcanised rubber of suitable hardness. The main difficulty was that the resulting partition could not be made thin enough to replace the aluminium partitions in the standard tank. Further experiments were in hand when the work had to be abandoned.

Defence Problems

In co-operation with the Institute of Medical Research tests were made on the utilisation of latex as an anti-shatter material for the protection of glass windows. Materials were tested by discharging a 12-bore shotgun at the treated glass, and although the test did not reproduce the actual conditions of bomb blast, it provided a useful method of comparing treatments.

Assistance on numerous other technical problems was given to the Military and Passive Defence Services.

At the request of the Health Authorities advice was given on the design of a still for the preparation of anti-malarial oil from scrap rubber.

Advisory Work

Demands on the staff for advice were heavy throughout the year, and particularly during the period of military embodiment at the beginning of the year. The predominant subjects of enquiry were sheet manufacture and the drying of rubber. Despite the shortage of building materials many new smokehouses were built. The R.R.I. tunnel continued to be the most popular type.

Many enquiries were received about the presence of bubbles in sheet. The commonest causes of this defect were wintering, abnormal weather, the opening of new areas, and the forcing of drying to secure maximum production from smokehouses. One unfortunate result of the increased incidence of bubbles was that estates discontinued settling their latex in order to reduce the delay between reception and coagulation. The resulting rubber was admittedly free from bubbles, but the standard of cleanliness declined. No satisfactory solution to this difficulty was found, and indeed there is little that can be done as long as the market penalises bubbles but takes no account of invisible dirt.

A series of monthly talks on rubber growing was broadcast from Singapore; Mr. W. S. Davey spoke on "The Work of the Plantation Chemist"; Mr. J. H. Piddlesden on "Factory Practice on Rubber Estates." Both talks were later published in the *R.R.I. Planters' Bulletin.*

Contract with the London Advisory Committee for Rubber Research, the Ceylon Rubber Research Scheme, and the British Rubber Producers' Research Association, was maintained, but collaboration was necessarily affected adversely by difficulties of communication.

From the middle of the year onwards Mr. Davey and some members of the junior staff spent much of their time on duty with the Passive Defence Services.

Lectures

Lecturer	*Place*	*Title*
J. H. Piddlesden	Nilai-Labu Branch of I.S.P.	Bare-Back Baling
W. S. Davey	Malayan Broadcasting Corporation, Singapore	Work of the Plantation Chemist
J. H. Piddlesden	-do-	Factory Practice on Rubber Estates

Publications

Publications in the *Journal of the Rubber Research Institute of Malaya* were as follows:

Communication	257	- V. H. Wentworth	-	The Absorption of Water by Rubber—Part 1
„	258	- V. H. Wentworth	-	Note on the Product of a Reaction between Aqua Regia and Latex
„	259	- Patent Specifications	-	Improvements in and relating to the Preparation of Softened Rubber.

Publications in the *R.R.I. Planters' Bulletin* were as follows:

No. 15—Rubber Cases: Plywood Tests
Bale Packing Specification

16—Shed for Drying Scrap and Lump Rubber
Note on packing Rubber in Plywood chests
The Work of the Plantation Chemist

18—Factory Practice on Rubber Estates

Part II—January 1942-August 1945

Towards the end of 1941, when war with Japan was imminent, the Divisional records and some of the laboratory apparatus were removed to the Experiment Station. This proved to be an unfortunate decision, as the offices at the Experiment Station were destroyed by fire early in 1942, and some of the files were lost.

During the period between the evacuation of the Institute and the establishment of control by the Japanese, a serious outbreak of looting occurred, and much of the Division's apparatus was lost. The junior staff voluntarily attempted to establish some order in the Division, pending a decision by the Japanese authorities concerning the future of the Institute.

In March, 1942, the Japanese re-opened the laboratories and the Chemical Division was put under the charge of Mr. K. C. Sekar. Most of the staff resumed duty, but numerous changes appear to have taken place during the years 1942 to 1945.

The work subsequently carried out was mainly a series of *ad hoc* investigations to evolve substitute materials for various purposes. The following notes on the Divisional activities have been compiled from information supplied by Mr. Sekar.

Latex

A considerable amount of time was given to the preparation of concentrated latex, and to the manufacture of rubber articles from latex. Probably the most important and useful work which the Division undertook during the whole of the Occupation period was the manufacture of surgical rubber goods. Existing stocks of medical supplies such as surgeon's gloves, ice packs and finger cots were soon used up, and the civil hospitals of Malaya were unable to procure replacements. The quality of articles produced in the R.R.I. laboratories was admittedly poor and the percentage of rejects was high, but the hospitals were supplied and credit is due to the Division for its enterprise. Other articles made from latex included mattresses and cushions composed of coconut fibre sprayed with compounded latex.

Numerous other latex applications were explored. Clay and wood dust compositions with latex on a plywood base were evolved and used for partition walls and ceiling boards. Compounds for patching leaks in roofing materials, for laying on floors, and for use as a substitute for concrete foundations for buildings, were tried with varying degrees of success. The use of latex as an adhesive for plywood was studied and a reasonably satisfactory formula evolved.

Attempts were made to prepare latex thread by extruding compounded creamed concentrate through glass nozzles into a coagulating bath followed by vulcanisation of the thread in a laboratory autoclave.

Because of the shortage of ammonia, latex used in these manufactures was preserved with the smallest possible amount of ammonia supplemented by caustic potash prepared from wood ash. Centrifuge concentrate was regularly prepared with a small Lister separator, the large Westphalia centrifuge having been removed by the Japanese to Batu Arang to make concentrate from caustic soda preserved latex.

Attempts to prepare new creaming agents by caustic soda extraction of castor oil cake and elephant yam powder were apparently unsuccessful.

Raw Rubber

Softened rubber made by incorporating a palm oil and caustic potash emulsion into latex before coagulation was used for the manufacture of sponge rubber.

It is reported that oil-resistant rubber films were made by dipping plywood into latex and exposing the film to chlorine gas for several days. Hydraulic brake washers showed improved oil resistance after being hardened by treatment with dry hydrochloric acid gas for one week. Another method used for improving oil resistance was to compound soft rubber with kapok, but although oil resistance was thus increased, other properties were simultaneously impaired.

Rubber samples from the Experiment Station and elsewhere were tested for the purpose of determining the effects of clone, tapping system and preparational treatment, but most of the test records have been lost.

Coagulants

Because of the severe shortage of acid coagulants much time was spent in devising substitutes. A practical method for the large-scale production from fermented toddy of a coagulant having an acidity equivalent to 4 to 5 per cent acetic acid was developed and recommended to producers. Toddy was regularly used at Sungei Buloh as a coagulant, and centres were established at various places in Selangor for its preparation and distribution to estates. Circular No. 16 "The Preparation of a Coagulant from Coconut Toddy" was issued.

Methods of preparing pyroligneous acid by dry distillation of coconut shell and rubber wood were also worked out, and described in Circular No. 17 "Preparation of Pyroligneous Acid for Coagulating Rubber Latex." One of the recommended methods of making a coagulant with acidity 2 to 3 per cent (as acetic acid) was to condense the vapours of mangrove charcoal kilns.

Experiments on heat and smoke coagulation were made, but the results were unsatisfactory. By immersing a tapping bucket of latex in boiling water and stirring, the latex could be thickened in about 30 minutes. It then rapidly curdled and coagulated. The coagulum was, however, unsuitable for the preparation of sheet, and the loss of rubber in the serum was about 6 per cent.

Another method of preparing dry rubber from latex was to pour latex into frames to a depth of about 8 mm, and then to place the frames in a smokehouse. Next morning the coagulum was stripped from the frames and machined and dried in the usual way.

Carbon black was prepared by burning tar in brick chambers and the black was used as a compounding ingredient in the preparation of various small rubber articles. Rubber oil was made by the destructive distillation of dry rubber and was used extensively as a substitute for anti-malarial oil, which was unobtainable.

J. D. Hastings,
Head, Chemical Division.

Kuala Lumpur,
21st October, 1947

REPORT FOR THE PERIOD JANUARY, 1941—AUGUST 1945

EXPERIMENT STATION

Part I—January-December 1941

Acreage Statement

Planted	1,228.16	Acres
Gardens and cleared land	10.00	„
Building sites and roads	66.18	„
Reserve jungle	47.16	„
	1,351.50	„

Details of planted area

In bearing on 31.12.1941	812.50	Acres
Immature including nurseries ..	415.66	„
	1,228.16	„

In addition to the above there are two seed gardens totalling 10 acres in the Forest Reserve. These areas are held under permit and are planted with *Hevea braziliensis* and *Hevea spruceana* for experimental purposes.

GOVERNMENT NURSERY AREA

An area of 200 acres on the Eastern boundary of the Experiment Station was allocated for development by the Experiment Station on behalf of the Department of Agriculture for the provision of planting material to smallholders.

DISTRIBUTION OF LAND

Botanical Division	915.58	Acres
Soils „	258.58	„
Pathological „	16.00	„
Chemical „	34.00	„
Smallholders Advisory Service ..	4.00	„
	1,228.16	„

Botanical Division Areas

New Planting. *Field 43—13 acres*

This area was previously planted with seed-at-stake but owing to serious damage by rats the growth was very poor and uneven with many vacancies. It was decided to replant the area and utilise it as a stock experiment. All jungle growths were then eradicated and the timber burned to avoid further damage by rats.

Various types of stocks including *Hevea spruceana* were budded with Pil. B.84, Tj.1 and P.B.86 and the field was planted with budded stumps in November 1941.

Areas budded. *Field 38—59 acres*

This field was planted in October, 1939. No burning was done, the jungle being contour-felled, individual platforms dug and germinated seed, three per hole, planted ten feet apart. Stand per acre 217 (approx.).

Budding commenced in September, 1941 and was completed in December. Legitimate seedling stumps of the 1939 hand-pollinations were also planted in November, 1941 in one part of the field.

Clones used for budding were:

R.R.I. Clones 523-529.

New clones made from 1939 hand-pollinated seedlings and illegitimate seedlings from various fields on the Experiment Station.

A few new clones developed by estates.

Pil. B.84 was used as control throughout.

The swampy areas were planted with budded stumps of R.R.I. 501.

Plot boundaries were clearly marked with a low, single-strand wire fence.

Clone Trial Areas

Field 5—40 acres

Tapping and recording of the nine clones in this field continued as usual.

Field 15—Clones from Estate mother-trees

Tapping was continued but the yields of only a few of the clones were recorded.

Yield records of clones were also taken in various other fields containing mixed clones and mixed seedlings and buddings.

Clonal Seedlings

Tapping and recording the yields of the families of clonal seedlings in Fields 9A, 17 D.N., 20A, 25(IV) and 26 were continued.

Tapping Experiments

Fields 5 and 6

The boundary rows were used in experiments to compare single-cut, double-cut, full-spiral and periodic systems.

Field 19A

A single-task experiment on B.D.5 to compare thirteen different systems. One tapper taps all the trees under the supervision of a divisional Field Assistant.

Field 21—Polyclone Area of seven clones

Tapped on the following systems:

1. S/2, d/1, m/2, 100%
2. S/1, d/4, 100%
3. S/2, d/2, 100%

Field 18A

In this field containing sixteen clones in rows running North-South (repeated four times) full-spiral tapping experiments were started during the year. The systems run East-West across the clones.

Planting Distance Experiment. *Field 14 C and D—Clone AVROS 50*

Tapping and recording continued.

Ecological Studies

Field 27

This experiment in which five kinds of cover crops are being compared was continued. This experiment also includes five different types of planting material.

On 1st July all buddings having a girth of 18 inches at 40 inches above the union were brought into tapping. Plot yields are recorded on two normal tapping days per month.

Immature Areas

Fields 32 and 33. Planted November, 1937

Some supplying was done with stumped buddings taken from doubles and the stand reduced to one plant per point. Natural covers were slashed to four feet.

Field 35—30 acres. Planted May, 1938

Some budding and supplying was done in the budded plots. Natural covers were slashed to four feet.

NURSERIES

Multiplication Nursery

Part of the overgrown budwood in Field 1 nursery was cut back. Some surplus clones were removed and the beds replanted with germinated seed. Compost prepared from oil palm refuse was forked in at the rate of fifteen tons to the acre.

Field 39 Nursery

Budding of the following N.E.I. clones was carried out in this nursery in June:—

Clone	Yards	Plants cut-back
AVROS 255 ..	5	46
„ 352 ..	5	74
L.C.B. 510 ..	5	43

Field 6A Nursery

All the unbudded plants were budded with R.R.I. clones 500-529. Some *Hevea spruceana* seeds were planted in one section.

Field 36 Nursery. Clone Pil. B.84

The Soils Division experiment in this nursery was discontinued (Annual Report 1939—p.227). Some thinning out was done to make the spacing three feet by four feet all over. Large plants were cut back to allow a new crop of budwood to come away. The nursery was extended by about half an acre towards the Eastern boundary and clonal seeds of Tj.1 and Pil. B.84 were planted.

Field 40. Nursery for supply of budwood to Smallholders

The following clones were budded:—

Tj. 1
Tj. 16
P.B. 25
P.B. 86

Sale of Planting Material

Budwood of new R.R.I. clones and a few proved clones was supplied to estates for experimental and other areas.

Large quantities of germinated clonal seeds and budded stumps were also despatched.

Hand-Pollination

Hand-pollination was carried out between the R.R.I. clones in Fields 14 and 30. Seeds were germinated and planted in a special nursery.

Root Studies

Root observation experiments were conducted by Dr. Baptist. A specially constructed steel tank with glass windows was let into the ground in Field 8 and observations and diagrams of root development were made periodically.

Sample Collection

Collection, drying, weighing and recording of cup samples was continued as usual. In most of the fields where the yields were being recorded, two cup samples per month were taken.

Measurements

Girth measurements were taken under the supervision of Field Assistants in all experimental fields.

Field, tree and row numbers were stencilled and renewed where necessary.

Soils Division Areas

Manuring Experiments

Manuring experiments in Fields 6, 13A, 17 D.N., 17C (replanted), 23 and 31 were continued (Annual Report 1939—p.226).

Some slight modifications were necessary owing to war-time scarcity of fertilisers.

Compost

About 150 tons of compost were prepared from oil palm refuse and *mikania* in the proportion of 2: 1. This was used in the nurseries.

Cultivation Field 19

Digging was done twice during the year.

Measurements

Girth measurements were taken in the same way as for the Botanical Division.

Pathological Division Areas

Routine inspection and treatment of all diseases were carried out during the year over the whole Station. Treatment of disease remained the same as in former years.

Fields 7 and 8

In these fields inspection was carried out periodically but there was no treatment, progress of the disease being marked by colour bands.

Termites

The general treatments for this pest were White Arsenic and Perchloride of Mercury. 5,776 trees were treated and 705 removed.

Bark Bursts

These were frequent in Field 19, clone B.D.5, during the latter part of the year and experimental treatments were carried out. War broke out before the experiments were completed.

Testing Chemical Sprays and Dusts

Experiments were carried out in Field 37.

Chemical Division

Samples of latex and sheet from various clones were sent to the Institute for the study of clonal characteristics.

Latex and samples of rubber from *Hevea spruceana* trees in Jungle Plot B were also sent for examination.

One temporary smoke house was built for demonstration purposes. A new shed for drying scrap rubber was constructed with an outside fire-box.

Experiments on bare-back baling were carried out.

Experiment Station—Routine and General

Weeding, grass slashing and lalang patrol continued as usual. Natural covers were slashed to three to four feet twice during the year. Repairs to terraces were necessary in some areas.

Drains were kept clean and free from weeds and deepened where necessary. The two main streams had the usual two

dredgings. In order to cope with the ever increasing erosion a number of strong cement bunds were put down in Fields 16, 35 and 37. This work was expensive but should be permanent. A considerable amount of work still remains to be done.

New Roads

Forty-eight chains of new hill road were constructed from the end of the existing road at the top of the hill (F.26) through F.38 to connect with the jungle boundary road. This work was done on Chinese contract. Gravelling was almost complete and culverts completed before the war. The gradient is about 1 in 17.

Manuring

General manuring was done in the following fields:—

Field	Quantity
1 A ..	2¼ lbs. per tree.
2 ..	4 „ „ „
3 ..	3½ „ „ „
4 C ..	4 „ „ „
5 A ..	2¼ „ „ „
9 A ..	2¾ „ „ „
12 ..	2¼ „ „ „
14 C & D ..	4 Cwts. per acre.
15 ..	3¼ lbs. per tree.
15 A ..	2¼ „ „ „
16 ..	3½ „ „ „
16 F ..	2¼ „ „ „
17 D.N. ..	2¾ „ „ „
17 D.S. ..	3½ „ „ „
18 A & B. ..	2¾ „ „ „
19 ..	3½ „ „ „
20 A & B ..	2¾ „ „ „
21 ..	4 „ „ „
22 A ..	4 „ „ „
22 B ..	2¾ „ „ „
23 A ..	2¼ „ „ „
25 ..	3½ „ „ „

The mixture used was as follows:—

Nitrate of Soda ..	12 parts	=	N ..	7.8%
C.I. Rock Phosphate ..	5 „	=	P_2O_5 ..	8.25%
Muriate of Potash ..	6 „	=	K_2O ..	15.6%

TAPPING

There was normal tapping on	262 days.
Late or interfered tapping on	78 „
No tapping due to rain and holidays ..	25 „

RAINFALL

Total for 10 months January-October 87.22 inches. Records for the last two months were lost.

CROP

A total of 545,344 lbs. of rubber was harvested during the year. This consisted of:

R. S. Sheet	373,543	lbs.
Compo	59,121	„
Cup lump	112,680	„
	545,344	„

NEW BUILDINGS

One new Field Assistant's bungalow was under construction at the end of the year. It was not completed when the war in Malaya started.

New Lines

Work was about to start on five sets of lines but this was abandoned on the outbreak of war in Malaya.

LABOUR FORCE, MEDICAL AND HEALTH

Health during the year was good. There were eighteen births and five deaths.

Details of Labour

	Workers	Dependants
Men ..	183	1
Women ..	119	16
Children ..	36	147
	338	164

Wage Rates

An increase of five cents was given in January with a further increase of five cents in April. Wage rates at the end of December were:

Men ..	60 cents.
Women ..	50 „

Labour Troubles

A strike among Tamil labourers broke out in the Klang area in April and spread rapidly throughout Selangor. The position became serious and the military had to be called in to stop rioting. The Station was not badly affected and the labourers were out for only seven days.

VISITORS

The number of visitors to the Station (records lost) was very much less than usual owing to the war and Planters being occupied with military duties.

STAFF

Mr. D. S. Thomson was appointed Manager, Experiment Station as from 1st March, 1941.

The Assistant Manager, Mr. R. F. Harley was acting Manager until the end of February. Mr. J. H. Tovey continued duties as Assistant.

All European members of the staff were embodied with the Volunteers during February and March. They were again called up for duty for about a fortnight during the Tamil strike. All were mobilised on 1st December when war seemed imminent.

Experiment Station Staff	Headquarters Staff
1 Chief Clerk	9 Botanical Division Assistants
1 Assistant Clerk	1 Soils Division Assistant.
1 Typist	2 Pathological Division Assistant
1 Dresser	1 Chemical Division Assistant
1 Field Assistant	1 Rubber Instructor
1 Tapping Field Assistant	
1 Junior Tapping Field Assistant	
1 Factory Clerk	

I have to record with appreciation the loyal assistance given by the staff during a particularly difficult year.

Part II—January 1942-August 1945

After the evacuation of Selangor in January 1942 little or no work was done until March when the Japanese assumed control of the Station. Although they recognised the special status of the Station, for the most part they took little interest in the work done there and left the Administrator to carry on with a minimum amount of supervision.

New Planting

The new planting undertaken during this period is described below:

(i) Field 45A November-December 1942. Legitimate seedling stumps of the 1940 hand pollinations. About five acres planted 20 feet x 20 feet.

(ii) Field 45B—October 1943. Legitimate seedlings stumps of the 1941 hand-pollinations and illegitimate seedlings. About five acres planted 20 feet x 20 feet.

(iii) A hedge-planting experiment, designed in 1940, was set up on 65 acres in 1943. The experiment was neglected and no supplying was done. After the reoccupation it was too late to remedy the results of the neglect and the experiment was abandoned.

All the above were planted on the land set aside for the Government Multiplication Nursery.

Budding

The tops of the hand-pollinated seedlings in Field 45 were useds to bud Fields 41 and 42 during 1942.

Hand-Pollination

Some hand-pollinations were made in 1942.

Tapping

Fields 6, 14C and D and 11 were tapped from April 1942 until the end of the period. Other fields were brought into tapping at various times and tapped fairly regularly for a year or more. Thereafter the tapping gradually declined and by 1945 only a very small crop was harvested. The standard of tapping steadily declined and wounding was common, many trees were left untapped and bark consumption was heavy.

Areas Felled

Two and a half acres in Field 4D and about 10 acres in Field 18C were cut out during this period. As these areas were not of great importance (Field 18C was earmarked for replanting in 1941) this loss was not serious. A few rows in Field 18B were felled by mistake.

Food Crops

All staff and labourers had to take an active part in the production of food crops. In and around the Station about

200 acres were cultivated with ragi, maize, tapioca and sweet potatoes.

An attempt to grow padi in the swampy areas of Field 18C was not successful.

Field Work

A certain amount of maintenance work such as weeding, draining, slashing covers and pest and disease treatment was carried on for a year or two but gradually the work deteriorated as labour became less fit or was employed more on food production and other works or left the Station.

Fortunately Field 38, budded in 1941, and Field 41 and 42, budded in 1942-43, were upkept during the critical period. Gradually natural covers got out of hand and lalang crept in in many fields, especially near the boundaries. Lalang was especially bad in Fields 41, 42, 43, 44 with large patches of sheet lalang in Fields 34, 38 and small areas in most of the other fields.

Nurseries

These were upkept in the beginning but later neglected and plants allowed to grow unchecked. Weeds and lalang crept into the unplanted sections especially in the Fields 6A and 39.

A few nurseries were planted with clonal seedlings but no manuring was done and the growth was poor.

Plot Boundaries

Wire fences used for demarcating plots in Fields 14, 27, 34 and 38—in all thousands of yards of wire—were looted.

The entire fence surrounding the boundaries was looted.

Curing

The factory was in operation throughout the period and the engines worked satisfactorily in spite of low grade and substitute oils.

Coagulating tanks and partition sheets were kept intact. Smoke houses were maintained in order. The packing shed was extended using materials salvaged from the office.

As the supply of formic acid soon ran out and further quantities were unobtainable, toddy acid was prepared on a large scale and used for coagulation.

Pyroligneous acid was also made from rubber wood.

Rubber oil was made from scrap and used as an anti-malarial oil.

Crop Harvested

1942	.. .. ..	336,876 lbs.
1943	.. .. ..	287,700 „
1944	.. .. ..	No records
1945 January to August	..	No records

BUILDINGS

The senior staff bungalows and guest house were stripped of all fittings and furniture. The hill bungalow being some distance away received special attention from looters and was badly damaged. A good deal of furniture from these bungalows was saved and distributed among members of the staff remaining on the Station.

One new partly built Field Assistant's bungalow was pulled down and the materials looted or used for various purposes.

The Office was burned down on or about 8th January, 1942 and most of the books and files were lost.

Other buildings demolished were the engine house, oil store and garage.

There were two periods when most of the damage and looting were done.

1. After the evacuation of the British and before the arrival of the Japanese.
2. After the capitulation of the Japanese and before the arrival of the British.

All other buildings were left intact but little or no maintenance work was done.

MACHINERY

The 5 h.p. Lister engine, 17 h.p. Ruston Hornsby engine and the sheeting battery were used throughout the period. The water pumps and pumping engines continued to operate.

The Station lighting plant and one bungalow lighting set and batteries were looted or destroyed.

WATER SUPPLY

A large portion of the pipe line to the jungle reservoir was looted. Water for all purposes was pumped from the stream in Field 22.

ANTI-MALARIAL WORK

This work was continued in a small way using rubber oil. Malaria cases rose sharply soon after the evacuation.

LABOUR

Comparative figures for labour force at the beginning and the end of the period:

	Workers		Dependants	
	1942	1945	1942	1945
Men ..	187	104	3	2
Women ..	115	86	10	15
Children ..	33	57	132	85
	335	247	145	102

No labourers were sent to Thailand and conditions on the Station were better than on most estates.

HEALTH

Owing to scarcity of medical supplies and the shortage of normal food supplies the health of the labour force gradually deteriorated. Malaria cases rose to over 40 per cent at one period. The death rate was high especially among young children.

STAFF

Mr. B. T. Hassan was in charge of the Experiment Station until April, 1942 when Mr. M. K. Nambiar, Botanical Division Field Assistant, was appointed Administrator by the Japanese and continued in this capacity until August, 1945. Mr. B. T. Hassan applied for and was granted indefinite leave and left the Station in April, 1942.

Messrs. J. G. Vincent, S. T. T. Pillai and B. K. Menon ceased to be employed as from May, 1942.

Mr. K. M. Sithamparam died in 1942. Mr. Wong Din disappeared in 1943 and is now presumed to have been killed.

D. S. THOMSON,
Manager.

SUNGEI BULOH,
August 1947

REPORT FOR THE PERIOD JANUARY 1941—AUGUST 1945

SMALLHOLDERS' ADVISORY SERVICE

During the period of the war and the occupation of Malaya the Smallholders' Advisory Service has suffered the loss of the two senior officers who were responsible for its pre-war development. Mr. Robert Meikle was killed in action near Rengit in Johore. Mr. Arthur Moore died while a prisoner-of-war in Siam. To the personal loss which has been felt by members of the service which these two officers had built up has been added the handicap of reorganisation in the difficult post-war period without their knowledge and experience to guide developments.

The writer of this report assumed the duties of Smallholders' Advisory Officer on 1st October, 1946, and the report is compiled from reports and records surviving in the Institute after the liberation, supplemented by information supplied by members of the staff.

Part I—January-December 1941

Staff

The Smallholders' Advisory Service at the 31st December 1941 consisted of forty-one Rubber Instructors and twenty Rubber Demonstrators. These men were working during the year under the local day-to-day supervision of officers of the Agricultural Department. The administration of the service from headquarters was in the hands of Mr. R. H. Meikle, the Smallholders' Advisory Officer with part-time assistance from Mr. A. Moore, Personal Assistant to the Director.

The absence of Mr. Meikle on leave from 6th January to 19th August 1941 caused some loss of personal contact between officers of the Institute and the Rubber Instructors, but the scheme of appointing Superintendent Instructors which was continued on an experimental basis did much to remedy this.

Rubber Instructors

During 1941 seven new Rubber Instructors were appointed but two Instructors resigned during the year, giving a net

Distribution of Rubber Instructors and Rubber Demonstrators at 31st December, 1941

State or Territory	Area of smallholdings	Rubber Instructors				Rubber Demonstrators	Average area of Smallholdings per Instructor
		Malay	Chinese	Indian	Total		
Perak ..	274,366	5	2	1	8	3	34,296
Selangor ..	145,017	3	1	1	5	1	29,003
Negri Sembilan ..	103,965	2	1	1	4	1	25,991
Pahang ..	96,777	3	1	–	4	5	24,194
Total F.M.S. ..	620,125	13	5	3	21	10	29,530
Malacca ..	73,571	1	1	–	2	–	36,785
Province Wellesley ..	23,824	–	1	–	1	–	38,963 (i)
Penang ..	15,139	–	–	–	–	–	—
Singapore ..	21,153	–	1	–	1	–	21,153
Labuan ..	1,886	–	–	–	–	–	—
Total S.S. ..	135,573	1	3	–	4	–	33,893
Johore ..	394,766	6	2	–	8	1	49,346
Kedah ..	108,387	3	–	–	3	2	37,344 (ii)
Perlis ..	3,646	–	–	–	–	–	
Kelantan ..	61,489	1	–	–	1	3	61,489
Trengganu ..	28,844	1	–	–	1	3	28,844
Brunei ..	8,298	1	–	–	1	1	10,184 (iii)
Total U.M.S. ..	605,430	12	2	–	14	10	43,245
Total Malaya ..	1,361,128	26	10	3	39	20	34,901
Experiment Station ..	—	–	–	1	1	–	—
Leave ..	—	–	–	1	1	–	—
Total ..		26	10	5	41	20	

Notes.

(1) (i) Includes Penang. (ii) Includes Perlis. (iii) Includes Labuan.

(2) Indian owners in Malacca were advised by the Indian Rubber Instructors stationed in Negri Sembilan and North Johore.

(3) Areas of smallholdings are taken from "The Malayan Agricultural Journal" Vol. 29, No. 7, July 1941.

increase of five for the year. An Indian Instructor's appointment was terminated from 31st December but his name remained on the strength at that date.

The new Instructors had all passed the diploma course at the School of Agriculture, Malaya, and consisted of three Malays and four Chinese. Five came direct from the school, and two had previous experience of three to four years elsewhere. The 1940 procedure of giving suitable candidates a month's training at the Experiment Station prior to the selection was repeated.

The complement of Rubber Instructors consisted of twenty-six Malays, ten Chinese and five Indians and their allocation to the different states and settlements is shown in the accompanying table.

Rubber Demonstrators

The policy of relieving Malay Rubber Instructors of some of the routine work of demonstration by employing suitable men from the kampongs as demonstrators was continued and at the end of the year there were twenty Rubber Demonstrators compared with fifteen at 31st December 1940. Rubber Demonstrators are particularly valuable in the more backward districts where the simple lessons on sheet manufacture are still of primary importance. The distribution of Rubber Demonstrators, included in the list of Rubber Instructors, shows the higher proportion of demonstrators employed in the states of Pahang, Kelantan and Trengganu.

Superintendent Instructors

In preparation for the scheme of creating Superintendent Instructors, two selected Rubber Instructors made separate tours of visits. One tour in March was in Malacca and Johore, another in August in Kedah and Province Wellesley and a third in September in Perak. These tours were successfully carried out and provided useful information to headquarters.

Rubber Instructors at the Experiment Station

During 1941 three Rubber Instructors were stationed, for separate periods of about four months each, at the Experiment Station. A Chinese, Malay and Indian Instructor benefited in turn from this "refresher" course and did useful work in showing Asiatic visitors round the station.

General

Field Work

The increased scale of replanting during 1940 and 1941 required much of the attention of Rubber Instructors. At the same time every attempt was made to ensure that earlier advisory "drives" on subjects such as sheet production and tapping were not allowed to be forgotten by the smallholder. Each Malay Rubber Instructor was allowed to spend $25 on a selected smallholding, the owner of which had applied for permission to replant. The money was for use on operations which the smallholder would not normally undertake and these included budding, manuring and terracing. These areas were carefully chosen and on some replanting was completed during 1941.

Steady increases throughout the year in the price of un-couponed rubber caused a resumption of tapping in many areas of which the owners had previously been content either to sell the coupons or use them to cover rubber from better yielding sources. The larger area tapped accentuated the shortage of suitable coagulants and resulted in the use of inferior substances including alum.

The drastic fall in the value of coupons was a serious blow to the owners who had replanted, particularly for the owners of very small areas who had replanted their complete holdings and were thus left with an insignificant income. This, and the high cost of labour prevailing, provided a serious set back to further replanting and to the proper care and maintenance of replantings already effected.

Improved Planting Material of Smallholders

In order to ensure an adequate supply of approved material for all smallholders who might undertake replanting, work on the central government budwood nursery at Sungei Buloh commenced during 1941. Approximately 192 acres had been felled and cleared by December and of this 35 acres had been planted with seedlings and a further 64 acres were ready for planting. This nursery was under the direct supervision of the staff of the Experiment Station.

Experimental Work at Ampang

Routine maintenance of the Institute's holdings at Ampang and near the Institute continued under the supervision of the Field Assistant in charge.

SMALLHOLDERS' RUBBER ADVISORY COMMITTEE

The second and third meetings of this committee were held at the Rubber Research Institute towards the end of 1941. Matters concerned with the organisation and administration of the Smallholders' Advisory Service, advisory policy, and possible lines for development of propaganda, were considered.

Part II—January 1942-August 1945

On the staff of the Smallholders' Advisory Service at the time of the invasion of the country only three Rubber Instructors who lived in Kuala Lumpur and the Field Assistant in charge of the two smallholdings in the Institute's possession were retained in the employment of the Institute. Other Instructors, scattered throughout the country, had to find alternative employment. Some of these were absorbed in the Agricultural Services of the various States, others obtained employment on large estates administered by the Japanese. In such positions the Instructors were sometimes able to render useful service to the country by diverting the Japanese zeal for felling rubber trees to areas which were least valuable.

The three Instructors who remained at the Institute were employed in the establishment of toddy acid coagulant centres throughout Selangor, and also worked on the heat coagulation of latex.

The area of mature rubber on the Ampang Road holding was cut out to provide a communal food crop area for the Institute's staff.

A small area of rubber was felled at Ulu Klang and the Institute's labourers were allowed to cultivate this.

L. R. DAVIDSON,
Smallholders' Advisory Officer.

KUALA LUMPUR,
11th February, 1947

REPORT, JANUARY 1941 - AUGUST 1945

SOILS DIVISION

Index

	Page
Advisory work	6
Cover plants and soil management:	
Mulching	4
Lateral and leguminous covers	4
Fertilisers:	
Supplies of	2
Time of application of	3
Japanese occupation period	6
Laboratory work:	
Phosphate analysis	5
Phosphate fixation	5
Soils analysis	6
Manuring:	
Mature rubber	2
Young rubber in new clearings ..	2
Young rubber in replantings	3
Oils from rubber	7
Paint, damage by	3
Soil survey work	1
Staff	1, 6
Wind, damage by	3

REPORT, JANUARY 1941 - AUGUST 1945
BOTANICAL DIVISION

Index

	Page
Advisory work	32, 39
Bark renewal, stimulation by Palm Oil ..	25
Breeding investigations	17, 36
Budgrafted trees:	
Growth and yields	10, 35
Summary of yields at R.R.I. Experiment Station	10
Tapping experiments on R.R.I. Experiment Station	10
Tapping experiments on various estates ..	10, 36
Clonal Seedlings:	
As stocks for budding	31
Trials	22, 37
Clones:	
R.R.I. 500 Series	20
from illegitimate seedlings	20, 37
from 1939 crosses	20
from 1940 crosses	37
Density-of-planting experiments:	
at R.R.I. Experiment Station	35
on estates	32
Ecological studies	30, 38
High-budding experiments	9
Field experiments on estates:	
Clone trials	22, 39
Density-of-planting	32
Field experiments on R.R.I. Experiment Station	31, 38
Girth rate and yield correlation	16

Growth-promoting substances:
Treatment of budded stumps 9
Treatment of Hevea seeds 28
Illegitimate seedlings, fields of 22, 37
Legitimate seedlings:
1928-1931 series 20, 37
1939 series 20
1940 series 37
1941 series 37
Manuring, effect on tapping systems .. 16
Physiological investigations:
Analytical procedure 25
Bark renewal, stimulation of 25
Nutrition, pot-culture experiments .. 22
Seeds, treatment of with growth substances 28
Yield stimulation by scraping and application of oils 28
Planting densities 32, 35
Pollination by hand:
Large scale 20
Results for 1941-1942 .. .. .. 17, 36
Pot culture experiments 22, 37
Propagation, vegetative 8
Publications 33, 40
Root pruning of budded stumps 9
Seedlings from isolated seed gardens .. 22
Seedling trees, comparison of tapping systems on 10
Selection and breeding:
Clones collection 17, 36
Clones from 1939 crosses 20
Clones from estate mother-trees .. 17, 36
Hand pollination 17, 20, 36
New clones from illegitimate seedlings .. 20

Staff 8, 33

Stock-scion relationship in buddings:
- Clonal seedlings as stocks for buddings .. 9, 31
- Influence of scion on yield of stock .. 9, 35
- Twin-plant experiments 9, 35

Tapping investigations:
- Budded trees, large-scale experiments on .. 12
- Budded trees, single-task experiments on .. 12
- Miscellaneous tapping experiments .. 16
- New, undertaken during the year .. 12
- Seedling trees, experiments on 10
- Tapping systems, experiments on R.R.I. Experiment Station 10, 11
- Tapping systems, experiments on estates 16, 36
- Tapping systems and manuring .. 16
- Tapping systems and rate of growth .. 16

Vegetative propagation 8, 35

Yields:
- And tapping costs 12, 16
- Clones from legitimate seedlings (R.R.I. 500 series) 20
- Clones from legitimate seedlings 1928-1931 series 20
- Clones on R.R.I. Experiment Station .. 10
- Illegitimate seedlings 22
- Isolated seed garden seedlings 22

REPORT, JANUARY 1941 - AUGUST 1945
PATHOLOGICAL DIVISION

Index

	Page
Advisory work	61
Bark bursts	58
Carbon bisulphite	60
Ceratostomella fimbritia	65
Cockchafers	59
Coptotermes	58
Corticium salmonicolor	57, 67
Giant snail	60, 67
Latex bacteriology	60
Leaf diseases	57
Microbiology of latex	60
Mouldy rot	65
Napthalene	58
Oidium heveae	56, 65
Paradichlorbenzene	58
Petrol as fumigant	60
Pink disease	57, 67
Psilopholis	59
Publications	68
Root disease investigations:	
Experiment B.K.1	42, 63
„ B.K.2	48, 63
„ G.1	53
„ H.1	45, 63
„ H.2	48, 63
„ L.P.1	53, 63
Rubber oil as fungicide	62, 67
Snails	60, 67
Sodium arsenite from local arsenical residues	63
Staff	41, 62
Stem diseases	57, 67
Tapping panel diseases	57
Termites	58, 67
White ants	58, 67

REPORT, JANUARY 1941 - AUGUST 1945
CHEMICAL DIVISION

Index

	Page
Advisory work	77
Aqua regia reaction product	75
Bale packing	75
Carbon black	81
Centrifuge skim	71
Cetyl pyridinium chloride as preservative ..	70
Coagulants	80
Coloured crepe	73
Compounding ingredients	74
Creaming of latex	71
Defence problems	76
Dirt in rubber	76
Discolouration of latex	70
Drum linings for latex shipment	70
Estate technique	75
Glenshiel 1, instability of latex	71
Kapok fibre	74
Instability of latex	71
Latex:	
Acetone extract	69
Chemistry and technology	69
Clarification by centrifuging	70
Cetyl pyridinium chloride as preservative	70
Hevea spruceana	72
Pentachlorphenol as preservative ..	70
Preservation	70
Thallium salts as preservatives	70

	Page
Lectures	77
Low water-absorption rubber	72
Manufacture of rubber articles	79
Modified rubber	72
Oil-resistant rubbers	74
Packing of rubber	75
Partitions for coagulating tanks	76
Publications	78
Pyroligneous acid as coagulant	80
Records, loss of	78
Rubber articles, manufacture of	79
Scrap drying shed	75
Smoke-houses	76
Sodium bisulphite	70
Sodium pentachlorphenate as creaming agent	72
Softened rubber	73
Staff	69
Sulphonated lorol as creaming agent	71
Technological studies of rubber	72
Toddy as a source of coagulant	80
Tunnel smoke-houses	76
Water absorption	72
Wax as lining for latex container	70

REPORT, JANUARY 1941 - AUGUST 1945
EXPERIMENT STATION

Index

	Page
Acreage	82
Anti-malarial work	94
Botanical Division area	83
Buildings	89, 93
Budwood, distributions	85
Chemical Division experiments	87
Clonal seed, distributions	85
Food crops	91
Hand pollination	86
Immature areas	84
Labour, health, medical	89, 94
Manurial trials	86
Manuring, general	88
Nurseries	85, 92
New roads	88
Pathological Division area	87
Rainfall	89
Routine field work	87, 92
Soils Division area	86
Staff	90, 94
Tapping	88, 91
Tapping experiments	84
Visitors	90
Water supply	93

REPORT, JANUARY 1941 - AUGUST 1945
SMALLHOLDERS' ADVISORY SERVICE

Index

	Page
Advisory Committee	99
Ampang demonstration plots	98
Coagulants	99
Instructors at the Experiment Station:	
Appointments	95
Distribution	97
Replanting	98
Rubber Demonstrators	97
Staff	95, 99
Superintendent Instructors	97

THE RUBBER RESEARCH INSTITUTE OF MALAYA

STAFF AT THE 31st DECEMBER, 1941

ADMINISTRATION

Director	H. J. PAGE, M.B.E., B.Sc. (Lond.), F.I.C., F.I.R.I.
Assistant to the Director	A. MOORE B.Sc. (Lond.), A.R.C.S.
Statistician	H. FAIRFIELD SMITH, B.Sc. Agric. (Edin.) M.S.A. (Cornell), F.S.S.
Small-holders' Advisory Officer	R. H. MEIKLE, B.Sc. (Edin.),

BOTANICAL DIVISION

Head of Division	C. E. T. MANN, M.Sc. (Lond.), F.I.R.I.
Botanist	C. C. T. SHARP.
Botanist	E. D. C. BAPTIST, Ph.D. (Lond.), M.Sc., A.R.C.S., D.I.C.
Botanist	N. WRIGHT, B.Sc. (Lond.), A.R.C.S., A.I.C.T.A.
Botanist	R. SCOTT RUSSELL, Ph.D., M.Sc., D.I.C.
Assistant Botanist	K. N. KAIMAL, B.A. (Madras).
Assistant Botanist	T. V. VAIDYANATHAN, B.Agric. (Bombay),

CHEMICAL DIVISION

Head of Division	W. S. DAVEY, B.Sc. (Lond.), F.I.C., F.I.R.I.
Chemist	J. D. HASTINGS, B.Sc. (Lond.),
Chemical Engineer	J. H. PIDDLESDEN, M.Sc. (Lond.), A.R.C.S., D.I.C., A.M.I.Chem.E.
Chemist	V. H. WENTWORTH, B.Sc. (Lond.), A.I.C., A.I.R.I. (Sc.), A.R.Ae.S.I.
Chemist	Vacant
Assistant Chemist	K. C. SEKAR, B.A. (Madras)

PATHOLOGICAL DIVISION

Head of Division	F. BEELEY, B.Sc. (Leeds).
Pathologist	R. P. N. NAPPER, M.A., Dip. Agric. (Cantab.).
Entomologist	L. D. E. F. VESEY FITZGERALD, B.Sc.Agric. (Lond.), Dip. Agric. (Wye), A.I.C.T.A.
Assistant Pathologist	K. P. JOHN, B.A. (Madras)

SOILS DIVISION

Head of Division	C. G. AKHURST, B.Sc. (Lond.), A.R.C.S., A.I.C.T.A.
Soils Chemist	G. OWEN, M.Sc. (Wales).
Advisory Officer	L. R. DAVIDSON, B.Sc. Agric. (Edin.).
Assistant Soils Chemist	K. S. PILLAY, B.A. (Madras), F.C.S.

EXPERIMENT STATION

Manager	Vacant.
Assistant Manager	R. F. HARLEY, A.I.S.P.
Assistant	J. H. TOVEY.

OFFICE

Secretary	H. S. BLACKLIN
Assistant Secretary	T. P. S. SUNDRAM, F.F.C.S., A.C.R.A.

London Advisory Committee for Rubber Research. (Ceylon and Malaya).

As at 31st December, 1941.

Mr. P. J. BURGESS, M.A., F.C.S. (*Chairman*)	Nominees of the Rubber Growers' Association
Mr. Eric Macfadyen	
Mr. J. L. Milne	
Mr. G. H. Masefield	
Mr. George Brown	
Lt.-Col. J. Sealy Clarke	Nominee of the Research Association of British Rubber Manufacturers.
Dr. H. A. Tempany, C.B.E., F.I.C.	Nominee of the Colonial Advisory Council of Agriculture and Animal & Health.
Mr. J. Lornie, C.M.G., M.A., B.Sc.	Nominee of the Malayan Government.
Vacant	Nominee of the Ceylon Government.
Sir Harry Lindsay, K.C.I.E., C.B.E.	The Director, Imperial Institute.
Professor V. H. Blackman	The Director, Botanical Laboratories, Imperial College of Science and Technology.
Dr. S. P. Wiltshire, M.A.	The Director, Imperial Mycological Institute, Kew.
Sir E. John Russell, O.B.E., D.Sc., F.R.S.	The Director, Rothamsted Experimental Station.
Mr. J. A. Nelson, B.Sc., (*Secretary*)	Imperial Institute, London, S.W. 7.

Technical Sub-Committee.

All the members of the London Advisory Committee with the addition of the following co-opted members:

Dr. J. R. Scott, M.Sc., F.I.C., F.I.R.I.
Mr. H. N Ridley, C.M.G., M.A., F.R.S.
Dr. S. S. Pickles, F.I.C., F.I.R.I.
Dr. D. F. Twiss, F.I.C., F.I.R.I.
Dr. H. P. Stevens, M.A., F.I.C.
Mr. G. E. Coombs, B.Sc.
Mr. G. G. Balazs.

STAFF.

Superintendent of Laboratories ..	G. Martin, B.Sc., F.I.R.I.
Chemist	H. C. Baker, M.Sc., A.I.C., A.I.R.I.
Chemist	W. G. Wren, B.Sc., A.R.C.S.
Technical Assistant	F. J. Coker, L.I.R.I.
Technical Assistant	J. Pannell, L.I.R.I.

Edited by C. C. T. Sharp on behalf of the Board of the Rubber Research Institute of Malaya.